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AUTHOR Greiner, Ted: And Others
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ABSTRACT

This monograph focuses attention on economic considerations related to infant feeding practices in developing countries. By enlarging on previous methodologies, this paper proposes to improve the accuracy of past estimates of the economic value of human milk, or more specifically, the practice of breastfeeding. The theoretical model employed incorporates (1) health and disease effects and costs, (2) goods costs (foods, materials and implements) and (3) time costs for both artificial feeding and breastfeeding. Terms of the model are extensively discussed. The model is subsequently employed to estimate the relative costs of bottle and breastfeeding in Ghana and the Ivory Coast for both individuals and the nations. In theory, if a mother breastfeeds an infant for two years, the average family in the Ivory Coast would save between US $591 and $723 in goods and time costs. The further savings due to the lower goods and time costs of disease and malnutrition for those who practice breastfeeding would be substantial. Similarly, the average Ghanian family could save between US $591 and $724. Most of the national level calculations attempted were done to illustrate simple analytic methods for achieving rough estimates from inadequate data. Conclusions which could be drawn from this study are limited because it is based almost entirely on preexisting data. Findings of this monograph are intended to encourage further research, promote breastfeeding and prevent the spread of bottle feeding in developing countries. (Author/RH)

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Cornell University
Program on International Nutrition
and Development Policy

THE ECONOMIC VALUE OF BREASTFEEDING
(with results from research conducted in Ghana and the Ivory Coast)

by
Ted Greiner, Stina Almroth and Michael C. Latham

Cornell International Nutrition
Monograph Series
Number 6 (1979)

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Program on International Nutrition

Copies may be obtained from:

Dr. Michael C. Latham
Division of Nutritional Sciences
Savage Hall, Cornell University
Ithaca, New York 14853, U.S.A.

Further information on the study is available from:

Ted Greiner
Division of Nutritional Sciences
Savage Hall, Cornell University
Ithaca, New York 14853, U.S.A.

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ERRATA

P. 15 5.a. Calculation of food costs.
First paragraph, second sentence should read, "Therefore, the only goods cost for breastfeeding is the cost of the extra food that the mother has to eat in order to produce the milk."

P. 36 Table 11, first column, "Age of child (months)" should read, "≤ 5" and "≥ 6".

P. 45 A.1.a.i. Method
First paragraph, first line. Omitted page numbers are "15-23".

P. 48 Table 17, sixth column, "Daily cost of rice and peanut sauce, US$" should read, 0.097, 0.081, 0.054 and 0.070.

P. 55 Second paragraph, second line. "US 50.37" should read "US $0.37".

P. 56 Center of page. The first three terms for which dollar estimates are made should read as follows: "$\sum_n G_{af_j}$", "$\sum_m G_{bf_i}$" and "$\sum_p T_{af_k}$".

P. 56 Last paragraph, third line. "US $59" should read "US $591".

P. 71 Omitted table heading for columns 2-7 (Avitaminosis - Measles), should read "Per cent of all diagnoses".

P. 78 First paragraph, second line. "page 19" should read "page 18".

P. 90 3.a. (1) ii. Results
First paragraph. The first word in the sixth line should be "urban" instead of "rural".

P. 117 Fourth paragraph, third line. "40 metric tons" should read "50 metric tons".

Also attached are amended Tables 4 and 23.

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PREFACE

This monograph focuses attention on certain economic considerations related to infant feeding practices in developing countries. Widespread decline in breastfeeding has for some time been a matter of concern to the authors. We believe that there are good cultural, physiological, medical, psychological, economic and other reasons why breastfeeding is desirable for nearly all infants.

Those of us who are advocates for breastfeeding, and who oppose inappropriate bottle feeding, are often accused of doing this without adequate research evidence to support our views. There are now extensive data to show the advantages of breast over bottle feeding. For example, the last decade has produced very important studies which show that the "unique immunochemical and cellular constituents of human milk are responsible for the decreased incidence of infections, and of allergic disorders, in breast fed infants" (Chandra, 1978). There is clear evidence of the role that breastfeeding plays in reducing fertility, and therefore in widening the gap between births. Research data now suggest the importance of early breastfeeding in mother-infant bonding. Studies, new and old, confirm the good nutritional status of young infants adequately fed from the breast, and the dangers of malnutrition in those fed contaminated and overdiluted formulas. The present study was conducted to review, and to add to knowledge concerning, the costs of breast and bottle feeding.

This monograph was made possible by a grant from the Norwegian government agency for development aid (NORAD) to the Food and Agricultural Organization of the United Nations (FAO). The funds were used to pay for the services of two of the authors (Stina Almroth and Ted Greiner) to spend time at FAO headquarters in Rome and then to undertake a study in Ghana and the Ivory Coast. The project was planned jointly by staff of the Food Policy and Nutrition Division of FAO and a group at Cornell University. On the basis of data gathered in West Africa, and an extensive review of the literature, the first draft of this monograph was produced at Cornell University. Revisions were then made as a result of advice and assistance from staff at FAO in Rome.

The authors are very appreciative of the support provided by NORAD and FAO. The many persons in FAO who provided time and help are too many to name. We are especially indebted to Franz Simmersbach and Jean McNaughton for their assistance. They both gave most generously and willingly of their time, and always had helpful advice.

This monograph is designed for scientists, nutritionists, physicians, economists and others who may be interested in research or programs related to infant feeding. Despite the assistance given by many people, including those at FAO and Cornell, the views expressed are those of the authors.

FAO are publishing, both in English and French, a shorter version of this paper in their Consultant Report Series. This is entitled "The Economic Value of Breastfeeding (with results from research conducted in Ghana and the Ivory Coast)". That report is based on the same materials, and is shorter and less academic than the present monograph.

We share the views of the Jelliffes that "no single pediatric measure has such widespread and dramatic potential for child health as a return to breastfeeding" (Jelliffe and Jelliffe, 1979). We hope that in some small way this monograph can contribute not only to that return, but also to a prevention of the spread of bottle feeding.

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I. INTRODUCTION

The process of planning for economic development must involve weighing the relative importance of many human problems. The proper allocation of limited resources in dealing with those problems demands access to the fullest possible knowledge about the potential costs and benefits of alternative courses of action. Improved human health has long been viewed as an important outcome or goal for economic development, but recently many economists have suggested that improved health may itself be important in fueling economic development (Berg, 1973; Stevens, 1977).

Perhaps the single greatest health problem in the modern world is infant malnutrition (Harrar, 1974). Recognition of the crucial role of breastfeeding in promoting infant health and nutrition has been growing rapidly among health professionals in recent years. But this awareness has come late, and it appears that decades of apathy toward breastfeeding on the part of many health professionals have contributed toward its decline in many parts of the world (Greiner, 1977c; Psiaki and Olson, 1978).

While the profound threat to infant health posed by a decline in breastfeeding in the Third World is receiving increased recognition, little research has focused on the economic implications. For this reason the present monograph has three main purposes: (1) to draw together much of what is known about the economic value of breastfeeding, (2) to develop a theoretical model for the economic value of breastfeeding, and (3) to illustrate some economic implications of hypothetical changes in patterns of breastfeeding in two developing countries, Ghana and the Ivory Coast.

Ghana and the Ivory Coast, though neighboring countries in West Africa, illustrate different approaches toward economic development. It is especially difficult to generate reliable economic analyses for Ghana, because of the marked inflation and rapidly changing economic situation there. Yet perhaps it provides a useful illustration of problems which are shared at least in part by a large number of developing countries.

Both countries are representative of the majority of Third World populations in which breastfeeding only recently has been in danger of any marked decline. Efforts to preserve breastfeeding in such areas would require fewer resources than for example in urban areas of Southeast Asia or Latin America where a noticeable decline has occurred over several decades.

The monograph is an expanded version of a report published simultaneously by the Food and Agriculture Organization of the United Nations (FAO) who commissioned the authors to write it. Funding was provided by the Norwegian Agency for Development aid (NORAD). This version deals in more detail with methodological and conceptual issues relevant to the economics of breastfeeding than does the FAO report. It may be of value to researchers or planners interested in analyzing the economic value of breastfeeding in other countries. The present monograph also presents a somewhat broader range of data on health and nutrition in Ghana and the Ivory Coast which may be of interest to those who wish to view the economic value of breastfeeding in those countries within a broader context.

II. BACKGROUND

A. Past Research on the Economic Value of Breastfeeding

The economic value of human milk, like that of any food commodity, can be viewed in purely monetary terms. Indeed, the pecuniary value of human milk is substantial and has been explored by a number of investigators. Data on costs of artificial infant foods compared to food supplements for the lactating mother, mainly from Great Britain, have been used to argue that one method or the other was more expensive (Arneil, et al., 1975; Lillington, 1975; Buss, 1975; Creery, 1975; Jelliffe and Jelliffe, 1976). The accuracy of such estimates is improved somewhat by including the cost of utensils for bottle feeding (Westlake and Jones, 1975; Whichelow, 1976).

For the United States, comparisons of the costs of breast and artificial feeding were made for the American Public Health Association by Stitt, et al. in 1962 and by Heseltine, et al. in 1966, and for the U.S. Department of Agriculture by Peterkin and Walker in 1976. Further calculations were made by Lamm, et al. (1977). These researchers tend to find breastfeeding to be nearly as expensive if not more expensive than many artificial infant foods. This is partly because only the cost of the milk is taken into account. Also, the cost of breastfeeding may be overestimated. For example, Peterkin and Walker (1976) report that food for one week for the lactating mother costs $3.50 under the "thrifty" food plan and $5.50 under the "liberal" plan, while infant formula costs from $2.80 to $19.20 depending on the type of formula and its container. However, the lactating woman's caloric intake was increased by 1/3 rather than 1/4, as suggested by the U.S. RDA's (2000 calories plus 500 calories for lactation (NAS, 1974)). Also, $0.50 per week for vitamin D was included, whereas recent research suggests that this is needed neither by the infant (Lakdawala and Widdowson, 1977) nor by the lactating mother (Fairney, et al., 1977). When the cost of breastfeeding is recalculated to account for these two points, it comes to $2.30 per week under the "thrifty" plan and $3.90 under the "liberal" plan.

With respect to developing countries, much of the early work was done in the Caribbean by McKigney (1968, 1971 a, 1971 b). Habicht, et al. (1975) went beyond costs of artificial infant food and included costs of equipment and fuel for bottle feeding in Guatemala. Some work has dealt with the proportion of the average income or food expenditure of families in the Third World that would have to be spent for complete artificial feeding (Berg, 1973; FAO, 1975; Almroth, 1976; Latham, 1977; Greiner, 1977a). Attempts were made by the same authors to examine the potential economic impact of artificial feeding at the national level in various countries. Cameron and Hofvander (1976) provided more detailed estimates on the proportion of monthly salaries necessary for complete milk-formula feeding in 11 countries.

Recent research has attempted to broaden thinking about the economics of infant feeding, for example, to include the cost of time involved. Butz (1977) has theorized, from an economic perspective, how the incidence and duration of breastfeeding might be influenced by various environmental and motivational factors. The major investigator attempting to examine the implications of a broader conceptual framework in an applied fashion has been Popkin (1976; 1978; Popkin and Solon, 1976).

B. Scope of the Present Paper

This paper, by enlarging on previous methodologies, proposes to improve the accuracy of past estimates of the economic value of human milk. It should be stressed from the outset, however, that this fails to do justice to the true economic value of human milk. If economics is viewed more broadly as concerning the way people allocate limited resources toward alternative means of improving the quality of life, a number of valuable non-monetary contributions of human milk emerge. Some of these can be more satisfactorily quantified along scales other than dollars and cents, such as mortality, morbidity, or population growth. Others, though important even in an economic sense, are currently not quantifiable, such as psychological benefits. Finally, it is likely that all the benefits of human milk are not presently known.

Human milk can be viewed in many respects like other food commodities. For example, it could be stored in milk banks, and redistributed from areas of surplus to areas of scarcity. The Fourth World Food Survey includes a discussion of breast milk, pointing out that, "Breast milk is a commodity of very high nutritious value and low production cost which is potentially almost perfectly equitably distributed among the needy--something that, as has been shown, cannot be said about supplies of other types of food" (FAO, 1977:45). Breast milk is perhaps also unique in that many of its benefits are associated more with its method of delivery than its physical or nutritional properties per se. Thus it would be more accurate to say that one is dealing not so much with the economic value of human milk as with the economic value of breastfeeding.

C. A Theoretical Model

The value of breastfeeding, like that of any good or service, can be viewed in terms of the benefits it brings and the costs it incurs. However, since human infants cannot survive without a specialized type of diet, a realistic analysis of the value of breastfeeding must compare it with the value of an alternative substitute form of infant feeding. That is, we actually are concerned with the incremental value of breastfeeding over that of artificial feeding, expressed mathematically as,

$$BF_i = V_{bf} - V_{af} \qquad (1)$$

where BF_i represents the incremental value of breastfeeding, V_{bf} the absolute value of breastfeeding, and V_{af} the value of artificial feeding when used as a substitute for breastfeeding.*

The value of each form of feeding can be viewed as the difference between its benefits and its costs:

$$V_{bf} = B_{bf} - C_{bf} \qquad (2)$$

$$V_{af} = B_{af} - C_{af} \qquad (3)$$

where B stands for benefit and C for cost. Fitting equations (2) and (3) into

* Theoretically, only artificial feeds which substitute for breast milk need to be included in an economic analysis. Since supplemental foods must be added at four to six months of age whether or not breastfeeding is practiced, their cost need not be considered. In practice, however, this distinction is difficult to make, because breast milk is often partially substituted for by foods which are intended only as supplements. This is particularly true for "supplemental" bottle feeds, which often result in decreased breast milk output due to less sucking stimulation to the mother's nipples.

equation (1) we have

$$BF_i = (B_{bf} - C_{bf}) - (B_{af} - C_{af}) \quad (4)$$

In order to view benefits and costs separately, we regroup terms in equation (4) as follows:

$$BF_i = (B_{bf} - B_{af}) - (C_{bf} - C_{af}) \quad (5)$$

The benefits of each type of feeding are assumed to be derived from its health-producing effects, H, minus its disease-producing or harmful effects, D:

$$B_{bf} = H_{bf} - D_{bf} \quad (6)$$

$$B_{af} = H_{af} - D_{af} \quad (7)$$

Costs, on the other hand, will be assumed to be composed of the goods, G, and the time, T, necessary to "produce" each type of feeding:

$$C_{bf} = \sum_m G_{bf_i} + T_{bf} \quad (8)$$

$$C_{af} = \sum_n G_{af_j} + \sum_p T_{af_k} \quad (9)$$

where

i = 1...m additional foods eaten (or body reserves mobilized) by a lactating woman to produce breast milk

j = 1...n goods used in artificial feeding

k = 1...p persons participating in artificial feeding of the infant

Thus the cost of breastfeeding, C_{bf}, equals the summations of the costs of all additional foods eaten by the mother to produce the breast milk (whether that food is eaten before, during, or after the lactation period) plus the value of the mother's time utilized in breastfeeding. The cost of artificial feeding equals the sum of all the costs of the goods needed to feed artificially (e.g., milk, feeding bottles, and fuel and utensils necessary for cleaning and sterilizing the bottles) plus the sum of the value of the time of each person participating in the process of artificial feeding.

Equations 6-9 can now be fitted into equation 5, giving:

$$BF_i = \left[(H_{bf} - D_{bf}) - (H_{af} - D_{af})\right] - \left[\left(\sum_m G_{bf_i} + T_{bf}\right) - \left(\sum_n G_{af_j} + \sum_p T_{af_k}\right)\right] \quad (10)$$

Regrouping terms, we have:

$$BF_i = (H_{bf} + D_{af} + \sum_n G_{af_j} + \sum_p T_{af_k}) - (H_{af} + D_{bf} + \sum_m G_{bf_i} + T_{bf}) \quad (11)$$

That is, the incremental value of breastfeeding equals its advantages: (1) its health-producing effects, (2) avoidance of disease-producing or harmful effects of artificial feeding, (3) avoidance of expense of goods necessary for artificial feeding, and (4) avoidance of time spent in artificial feeding, minus its disadvantages: (1) the foregone health-producing effects of arti-

ficial feeding, (2) the disease-producing or harmful effects of breastfeeding, (3) the cost of food necessary to produce breast milk, and (4) the mother's time in breastfeeding.

D. Discussion of the Model

This section presents a discussion of the terms in Equation 11. For purposes of clarity and continuity, the terms in Equation 11 are not discussed in the order in which they occur in the equation. First the health and disease effects and costs are discussed, then the goods costs, and finally the time costs.

1. Health-producing effects of artificial feeding (H_{af})

a. Association between prevalence of artificial feeding and infant mortality

Some authors, noting that a decline in infant mortality in many cases accompanied a switch from breast to bottle feeding, have assumed that a causal relationship exists. For example, referring to the rapid decline in young child mortality in Barbados in recent years, Aykroyd (1977) wrote, "The main factor involved has been the adoption of artificial feeding." As Latham, et al. (1977) point out, a number of simultaneously occurring factors such as improved sanitation and health care are more likely responsible. In countries where such improvements preceded the switch from breast to bottle, the decline in infant mortality also preceded it. For example, in Sweden from the 1920's to the late 1940's, infant mortality dropped rapidly from nearly 75 to less than 25 per thousand live births, while the mean duration of exclusive breastfeeding in Stockholm remained fairly stable. During the next twenty-five years, breastfeeding declined rapidly, but infant mortality decreased only gradually (based on Vahlquist, 1975:11). In other countries, such as China, a rapid decline in infant mortality was achieved without any appreciable switch from breast to bottle.

b. Use of artificial feeding when breastfeeding is not possible

There has always been a small percentage of infants whose mothers die or are separated from them or who can not produce breast milk. Thus it is likely that the provision of adequate alternatives to human milk has been responsible for slight declines in perinatal mortality rates in areas where "economic and hygienic conditions have made it possible to use such formulas in an optimal way" (Hambraeus, 1977:33). When these conditions do not exist, as in most areas of the Third World, relactation (or induced lactation) may offer a greater hope for infants deprived of breast milk (Brown, 1977). However, because few people appreciate that relactation is possible, it must still be generally accepted that once a woman for any reason starts bottle feeding, then for that infant artificial feeding is likely to be the only feeding method used until solid foods are introduced.

In conclusion, there would appear to be little public health or economic significance of any health-producing effects of artificial feeding in the Third World, particularly any which would suggest benefit over breastfeeding.

2. Disease-producing or other harmful effects of breastfeeding (D_{bf})

a. Negative correlation between duration of breastfeeding and infant nutritional status

There are health professionals who feel that extended breastfeeding is somehow harmful. For example, Ramos-Galvan (1969) wrote, "I think it is hazardous to the personality development of the child to be breastfed more than one year...It is a dry breast; we have to realize that these mothers (in underdevloped countries) do not give any nutrients to the child and are interfering with emotional development."

It is true that, when the nutritional status of infants in developing countries is correlated with length of breastfeeding, a simple negative association may emerge, that is, infants breastfed for longer periods may have lower nutritional status (e.g., Oomen, et al., 1954). This appears to be the case in Ghana's National Nutrition Survey, leading Davey (1961a:19) to conclude, "There seems no doubt that breastfeeding for as long as 24 months is not to the child's advantage."

The negative correlation between length of breastfeeding and infant nutritional status is likely to be due to covarying factors rather than a harmful effect of breastfeeding per se. For example, older mothers (with more children) of lower socioeconomic status often tend to delay both the introduction of solid foods and the cessation of breastfeeding. Thus the beneficial effects of extended breastfeeding may be overshadowed by the negative environmental circumstances which often accompany it. When multivariate methods of data analysis are utilzed and these factors are controlled for, the association between weaning age and nutritional status is likely to be positive (e.g., Greiner, 1977b).

b. Disease-producing agents potentially transmitted through breast milk

Small amounts of certain drugs taken by a mother may be excreted into her breast milk. In most cases this will not be enough to harm the infant (Harfouche, 1970:152) and in the case of prophylactic antimalarials, may protect the infant against malaria. However, there are a number of drugs which should not be prescribed for a lactating woman. Alcohol, nicotine, and narcotics, when used in large quantities, can also be detrimental to the breastfeeding infant. However, these facts have little public health or economic significance in most developing countries.

In an area where environmental pollution is a problem, lipophilic contaminants can concentrate in the fat in breast milk (Harris and Highland, 1977). This could become a significant concern in Third World countries with increased use of pesticides for agricultural purposes and vector control, and as industrialization progresses. However, a number of factors need to be kept in mind in placing this potential problem in proper perspective. Firstly, no harm to human infants from agricultural or industrial chemicals in breast milk has yet been documented. Secondly, in a polluted area contaminants appear not only in breast milk, but also many of them are likely to appear in water, especially if it is untreated. In fact, it would seem likely that breastfed infants are protected from many environmental pollutants which (a) would be metabolized and/or detoxified by the mother, (b) would be excreted in lower concentrations in breast milk than they were present in water, and (c) would not be excreted at all in breast milk. Thirdly, low income mothers are less likely to ingest many lipophilic contaminants because of the lower level of fat, especially from animal sources, in their diets. Finally, there is always a risk that

pesticides will enter milk used for artificial infant feeding. Unless pesticide use around dairy cattle and in their feed is carefully controlled and unless the pesticide content of milk is constantly monitored, local cows' milk is likely to have higher levels than breast milk (and is often the main alternative to breast milk). In the United States recently, dieldrin was found in cows' milk at levels 10-13 times above the guidelines ("actionable level"). This was caused by a small quantity of feed which for unknown reasons was highly contaminated (Zaki, et al., 1978).

In conclusion, there would appear at present to be little public health or economic significance of pollutants in Third World mothers' breast milk, especially relative to the alternative danger of pollutants in water likely to be used in artificial feeding.

c. Insufficient quality or quantity of breast milk

While most studies have found that maternal malnutrition has little significant effect on breast milk composition (Thomson and Black, 1975) several contradictory findings suggest further research is necessary before definite conclusions can be drawn. Although levels of several vitamins may be decreased, only in the case of thiamine has this been shown to lead to a deficiency disease in the infant (Jelliffe, 1968:98). The fat content of breast milk, which has important implications for the caloric sufficiency of the milk, may be reduced in milk of malnourished mothers (Crawford, et al., 1977), but findings are contradictory (Nutrition Reviews, 1975).

In industrialized countries and among upper classes in the Third World insufficient production of breast milk is apparently a common problem. The causes are usually of a social and psychological nature. This has little public health significance, because such infants are promptly and successfully fed artificially.

Among most well-nourished Third World women in rural areas there appears to be little problem with insufficient breast milk production. Research to date has been insufficient to establish the extent to which maternal malnutrition can reduce breast milk output. Most studies show little effect of moderate maternal malnutrition on breast milk output (Thomson and Black, 1975; Lönnerdal, et al., 1976). It is perhaps worthwhile here to point out that a key issue concerning the economic value of human milk is that the human female can transform, very efficiently (See page 19), relatively inexpensive and unhygienic food and water into nutritious and hygienically safe infant food. Thus it should be clear that in nearly any situation in which maternal malnutrition is responsible for inadequate breast milk production, the solution would be to supplement the mother, not the infant.*

A number of other "alleged inadequacies of human milk" have been shown to be fallacious by Jelliffe and Jelliffe (1977). In fact, for none of these "disease-producing" aspects of human milk is there any true public health or economic implication that would suggest that artificial feeding might help avoid those problems. Thus the disease-producing effect of breastfeeding may be considered to be zero. If, as discussed above, the health-producing effect of artificial feeding from public health and economic

* There are rare exceptions, such as severe maternal malabsorption.

perspectives is also essentially zero, then equation 11 can be simplified to the following form:

$$BF_i = (H_{bf} + D_{af} + \sum_n G_{af_j} + \sum_p T_{af_k}) - (\sum_m G_{bf_i} + T_{bf}) \qquad (12)$$

3. Health-producing Effects of Breastfeeding (H_{bf})

The normal lactating woman provides breast milk which contains all the nutrients an infant needs for his/her first 4 to 6 months of life. Recent research has shown it to be more adequate than previously thought in vitamin D (Lakdawala and Widdowson, 1977), iron (McMillan, et al., 1976; Coulson, et al., 1977; Woodruff, et al., 1977) and water (Almroth, 1978).

After 4-6 months, supplemental foods must be introduced to meet the growing nutritional needs of the infant. However, the studies reviewed in Table 4 (page 22) show that the quantity of breast milk produced at later stages, even after two years, can be appreciable. During the critical second year of life, breastfeeding can make an important contribution in terms of calories (Rutishauser, 1974) and high quality protein (Gopalan, 1958).

Breast milk contains a large number of factors which help prevent disease. These include a substance or substances of uncertain composition usually referred to as the "bifidus factor", which helps sustain high levels of Lactobacillus bifidus in the gut of exclusively breastfed infants (György, 1971). This creates a low pH in the gut, probably inhibiting the proliferation of pathogenic bacteria. It has been demonstrated that this acid environment inhibits the in vitro growth of shigella, E. coli, and yeast (Goldman, 1973).

Human milk also contains a number of living leukocytes, mainly monocytic phagocytes, but also lymphocytes. The former are motile cells which phagocytose fungi and bacteria and may be responsible for synthesizing lysozyme and lactoferrin (Pitt, 1976). Lysozyme is a bacteriolytic enzyme which causes lysis by cleaving the peptido-glycans of the bacterial wall (Goldman, 1973). Wasz-Höckert, et al. (1973) found that infants fed human milk or formula with lysozyme added had significantly lower frequencies of gastro-intestinal infections than infants fed formula without added lysozyme. Lactoferrin is an iron-binding protein found at higher levels in human milk than in cows' milk. It appears to exert a bacteriostatic effect by chelating iron in the medium and thus making it unavailable for microorganisms (Bullen, et al., 1972). This effect is lost when lactoferrin is saturated with iron (as probably occurs in iron-fortified infant formula), but was found to be unaffected when iron supplements were given to lactating mothers (Reddy, et al., 1977).

All classes of immunoglobulins are found in human milk, with IgA predominating (Goldman, 1973). Antibodies in the IgA fraction appear to be particularly well suited for local action in the alimentary canal. They resist digestion, they do not need to fix a complement (the salt concentration and pH in the gut lumen are anticomplementary), and they adhere to the mucosal surface and resist absorption (South, 1971).

Breast milk appears to be especially effective in protecting infants from diarrhea (Brambell, 1970; Hanson, et al., 1975; Stoliar, et al.,

1976). Colostrum has been successfully used in hospitals to bring epidemics of intractible diarrhea under control (Tassovatz and Kotsitch, 1961; Larguia, et al., 1977). Antibodies to rotaviruses (probably a major cause of infant gastroenteritis (Flewett, 1976; Kapikian, 1977)) have been found in human colostrum, even when they are not present in the maternal serum (Inglis, et al., 1978). Potential anti-viral activity in breast milk has also been found by Lawton and Shortbridge (1977).

Many of the disease-protective factors are found not only in colostrum, but continue to appear in the mature milk. In fact, lysozyme levels seem to increase progressively during the period of lactation (Reddy, et al., 1977). Furthermore, they were found to be at similar levels in the milk of under-nourished, compared to well-nourished mothers (Reddy, et al., 1977).

Recent research suggests that breast milk provides active as well as passive immunity. Schlesinger and Covelli (1977) showed that infants appeared to acquire cell-mediated immunity from breast milk. Roberts and Freed (1977) showed that, although maternal secretory immunoglobulins are not significantly absorbed by the neonatal gut, colostrum is somehow able to switch on the neonate's own IgA-producing lymphocytes. These disease-protective factors may make the difference between life and death in a hostile environment, but even among relatively well-to-do families in industrialized countries, there appear to be significant differences in the health of breast-fed versus bottle-fed infants (Mellander, et al., 1959; Cunningham, 1977; Larson and Homer, 1978).

Breast milk has an exceptionally low renal solute load (Ziegler and Fomon, 1971). Because the concentration at which breast milk is fed is outside the mother's control, breast-fed infants avoid problems of over and under dilution, which bottle-fed infants are commonly subject to (Wilkinson et al., 1973), including hypernatremia and hypocalcemia (Department of Health and Social Security, 1974).

Breast-fed infants are less likely to become allergic to cow's milk protein, the most common allergen in infancy (Goldman, 1976). They have a much lower risk of cot death (Gunther, 1975). They may be less likely to develop abnormal coronary arteries (Osborn, 1968) and possibly lower serum cholesterol levels than bottle-fed infants (Fomon, 1976).

Breastfeeding may help protect against obesity. There is an automatic short-term limit on the quantity which the breastfeeding infant may consume (or at least a diminishing return on any efforts to obtain more than the usual quantity at any given feeding), though a longer-term hormonal response to sucking stimulation of the nipples leads to the adjustment of supply to demand. It has been suggested that the change in composition of breast milk during each feed--an increase in fat content as hindmilk comes in --may have an appetite-regulatory effect (Hall, 1975).

The possible psychological implications of breastfeeding versus artificial feeding are extensive (Newton and Newton, 1967), but inadequately studied so far. Lozoff, et al. (1977) have pointed out the crucial role that breastfeeding plays in mother-infant bonding, which in turn has an influence

on infant health, physical as well as emotional (Sosa, et al., 1976).

Recognition is rapidly growing of the importance of breastfeeding in delaying the postpartum return of fertility in the mother, especially when lactation is unsupplemented and prolonged (Buchanan, 1975; Van Ginneken, 1977). Rosa (1975) estimates, based on breastfeeding and family planning as they are currently practiced in the Third World, that "approximately one-third more protection is provided by lactation amenorrhea than by family planning program contraceptive methods."

4. Disease-producing or harmful effects of artificial feeding (D_{af})

a. Past research on harmful effects of artificial feeding

The distinction between the health-producing effects of breastfeeding and the disease-producing effects of artificial feeding in many cases must be somewhat arbitrary. Nevertheless, it is clear that the less ideal are the environmental and socioeconomic conditions under which families live, the greater is the difference between the health of breast- and artificially-fed infants. Thus large differences were found in the past in the United States (Grulee, et al., 1934) and England (Robinson, 1951), and more recently in many underprivileged populations. Bottle fed infants have been found to have lower nutritional status in Uganda (Welbourne, 1958), among American Navajo Indians (French, 1967), in Jamaica (Grantham-McGregor and Back, 1970), in Israel (Kanaaneh, 1972), in Lebanon (Kanawati and McLaren, 1973), and in St. Vincent (Greiner, 1977b). Many of these studies (French, Grantham-McGregor and Back, Kanaaneh, and Greiner) found diarrhea to be more common among bottle-fed infants, as did Sharma, et al., 1955 (in India,), Yekutiel, et al., 1958 (in Israel), and Almroth, 1976 (in Jamaica). In a large sample of Chilean infants, Plank and Milanesi (1973) found higher mortality rates among bottle-fed infants. The Inter-American Investigation of Mortality in Childhood (Puffer and Serrano, 1973) found that nutritional deficiency as a cause of death was more frequent among children who had either been breast fed for only limited periods or not at all.

b. Factors which cause artificial feeding to become harmful

Strictly speaking, modern artificial infant foods need not be harmful or disease-producing. An examination of equation 12 would suggest that various trade-offs may be the mechanisms or causal pathways explaining why artificial feeding is so often unsatisfactory in Third World countries. That is, a savings on any of the costs of artificial feeding, beyond a certain minimum necessary, can be achieved only at the expense of an increase in D_{af}. Three categories of trade-offs will be illustrated here.

i. Inadequate money

A substantial percentage of the rural population of many Third World countries hardly participate in the cash economy if at all. The calories for producing breast milk may be grown by the family or bartered for (or they may come from the mother's nutrient stores or through a reduction in her level of physical activity). However, successful artificial feeding requires a certain amount of capital to invest equipment (Almroth, 1976, and Greiner, 1977b, both found high correlations between measures of family socioeconomic status and the number of feeding bottles owned), and access to a re-

liable, continuous source of cash for recurrent expenses, especially the artificial infant food. The malnutrition resulting from the inability to purchase adequate quantities of artificial feeds, leading to their overdilution or partial substitution with less nutritious but cheaper foods (e.g., sugar water, herbal teas, etc), is well-documented (Berg, 1973:94; Jelliffe, 1962). Less visible, but perhaps more difficult to remedy is the inability of both the family and the society to make the capital expenditures necessary to ensure that artificial feeding will be adequately hygienic. The lack of clean running water may be the greatest limiting factor in many areas. A corner of an earth floor cannot serve as a safe place for storage of artificial foods and feeding utensils. An old soda bottle cannot act as a safe baby bottle. Sand shaken in a bottle cannot function as an effective bottle brush. The purchase of adequate quantities of chemical disinfectant is beyond the means of most of the world's mothers. But unless an extra stove and an extra pot besides the one needed for the family food can be purchased, and unless adequate extra fuel can be gathered or purchased, sufficient water cannot be boiled to permit artificial feeding to be safe.

ii. Inadequate time

To save time, mothers may prop infants' bottles while they are feeding rather than holding them. This may lead to an increase in the cost of artificial feeding because of the high cost of the otitus media or ear infection that results in some cases (Oseid, 1975). Similarly, letting an older baby walk around carrying his or her own bottle saves time, but probably leads to an increase in bottle-borne infections and milk wastage. When water must be carried over considerable distances, the tendency will be to use less for washing bottles and other hygienic purposes. It was found among migrant farm workers in the U.S. that "Adequacy of water supply for handwashing and general cleanliness was of greater significance than bacteriological safety of water consumed" (Stitt, et al., 1962:138). As the number of migrant families who shared a water faucet increased (and thus the distance required to carry the water), the prevalence rate of positive cultures of shigella (diarrhea-causing bacteria) increased (Watt, et al., 1953:735).

A mother under a severe time constraint may shift infant feeding duties to a person whose time is worth less than hers. While this substitute child caretaker may be equally or even more adept at general child care than the mother, s/he is likely to be less educated and less able to artificially feed the infant properly. This is clearly the case when a young child is acting as caretaker. In Ghana, it appears to be the case with the housemaids so commonly used by working mothers. Idusogie (1974:108), S. de Graft-Johnson (1974:119), and Kumekpor (1973:27) all state that housemaids are unreliable and occasionally the cause of malnutrition because of inappropriate child feeding practices. This may be part of the reason for the common finding, reviewed by Berg (1973:46), by Popkin and Solon (1976), and by Latham (1977:iv) that infants of working mothers, in spite of their mothers' increased income, suffer from lower nutritional status.*

*The high cost of replacing human milk with artificial milk is also likely to be part of the reason. For example, Reutlinger and Selowsky (1976) show that an unskilled urban Indian mother, who replaces 70% of her breast milk with cow's milk in order to work, will have to spend about 50% of her earnings in order to maintain her infant's nutritional status at a constant level.

Caution should be used in interpreting data that show a lower nutritional status among children of working mothers because working mothers may be more impoverished, i.e., poverty may be forcing them to contribute to the household income.

iii. Inadequate knowledge or education

Even where financial resources and time are adequate for proper artificial feeding, mothers--and other child caretakers--must be educated in proper methods of preparing hygienic, nutritionally adequate feeds. This would be a very expensive undertaking and if this expense were foregone, the inevitable trade-off would be an increase in D_{af}. An example is Libya, where "both gross poverty and inadequate housing have been largely eliminated and phenomenal social progress has been accomplished... yet infantile marasmus remains a widespread problem" (Pellet, 1976:54). In this society, where breast-feeding has declined, despite government efforts to encourage it, "social progress alone without the understanding of the causes of feed contamination by the mother is not enough. Unless a massive breakthrough in the education of women in Libya can be made, it appears that marasmus may persist even in a relatively rich society with adequate food availability (Pellet, 1976:55).

b. Economic analyses of harmful effects

In discussing the economic implications of the disease-producing effects of artificial feeding, the focus will be on malnutrition. While gastroenteritis is also an important disease which can result from artificial feeding, and other diseases do increase in incidence and severity with an increase in malnutrition (Scrimshaw, et al., 1968), more economic data is available on malnutrition because it has more often been the focus of economic research. This research has been done on malnutrition in general, and it should be kept in mind that only a portion of the malnutrition in any given area is due to artificial feeding. In the following three sections, the theoretical economic implications of malnutrition are discussed at three different levels, individual, family, and national.

i. Individual level

There are a number of pathways through which malnutrition and disease can have an economic impact on the individual victim. In the case where death results, this is obviously impossible to quantify. Permanent disability would have a clear impact on lifetime earning capacity, depending on its severity. Although malnutrition in infancy may lead to permanent stunting of physical growth, there is little evidence that this has important functional significance later in life (except that smaller women may experience more problems in giving birth (Cook, 1971)). There are some forms of permanent physical disability resulting from diseases associated with malnutrition, vitamin A deficiency blindness being an important one. Artificial feeding can be a causal factor if unfortified dry milk is used (WFP/CFA, 1976).

Severe malnutrition clearly has powerful short-term effects on an infant's mental development. Recent research in the Ivory Coast, for example, suggests that even moderate malnutrition may delay some forms of cognitive development, especially "active experimentation" (Dasen, et al., 1977). However, the question of whether malnutrition in infancy is associated with permanent mental disability is currently unresolved. For example, of two studies which have used sibling controls, Hansen, et al. (1971) were unable to find deficiencies in mental performance of malnourished South African children after 10 years, while Herzig (1972) did detect deficits in a study of Jamaican children.

Malnutrition in human beings is usually accompanied by a number of other environmental deficits which could also influence mental development. Latham and Cobos (1971) have hypothesized that the poor mental performance of previously malnourished children may be due not to organic damage, but to the reduced level of activity and learning opportunities which accompanies a caloric deficit. Barnes and Levitsky (1972), largely on the basis of work in animal models, similarly hypothesized that a "functional isolation" associated with malnutrition removes the child from aspects of the environment which foster mental development. But while it is not clear whether malnutrition per se causes the reduced mental development often found in previously malnourished children, it is clear that removing the causes of malnutrition also "will result in the intellectual betterment of those who live in the culture of poverty" (Latham and Cobos 1971:1323).

Recent research findings underscore the potentially important role of breastfeeding. Firstly, if malnutrition does cause organic brain dysfunction, as for example, Stoch and Smyth (1976) suggest, the timing of malnutrition may be important. Since the bulk of brain growth (cell hypertrophy) is complete by 2 years of age and brain cell multiplication (cell hyperplasia) by about 6 months, Stoch and Smyth feel that the earlier forms of malnutrition may be particularly damaging. Thus, the traditional weaning-age malnutrition occurring later in infancy might not have as severe an effect as marasmus occurring in a bottle-fed infant under 6 months of age. Secondly, if environmental stimulation is the key to optimal mental development, breastfeeding may be of crucial importance by helping to establish an early bond between the mother and infant (Lozoff, et al., 1977).

ii. Family level

The cost of malnutrition to the family begins with the cost to the victimized child. It is becoming clear that most Third World parents expect and in fact receive substantial economic returns from their children, beginning at relatively young ages (at least in rural areas when educational opportunities are limited) and continuing throughout the parents' life (Caldwell, 1967). To the extent that malnutrition reduces the human capital* of the child and his/her lifetime earnings, it is potentially economically costly to the family who would usually share in those earnings.

Infant malnutrition and disease entail further family goods and time costs. These sometimes include expenses for medical treatment and/or drugs, cost of transportation to and from the treatment facility, and cost of the time lost from work. When a child dies, all time and goods expended on his/her birth, (including extra food eaten by the mother during pregnancy), on his/her care and feeding during infancy, and on burial and mourning are wasted. These are often extremely high costs to the family.

iii. National level

Many economic costs of malnutrition, both to the victim and to his/her family, can be clearly conceptualized, even if it is not always possible to quantify them. However, even a purely theoretical model has yet to be de-

*"Human capital" refers to the concept that money can be invested in human beings, for example, by educating them, which will result in later increases in their productivity or earning capacity (See Schultz, 1961).

veloped for realistically analyzing the cost of malnutrition (or the savings to be realized from eliminating it) at the level of society or the nation. The difficulties involved are reviewed by Call and Longhurst (1972) and by Hakim and Solimano (1976).

The impact of malnutrition on a nation has been conceptualized at the simplest level as an extrapolation of its effects on the individual. If malnutrition lowers the productive potential of individuals (by impairing mental and phsyical abilities, contributing to illness and reducing the life span), it is assumed to reduce the overall productive capacity of a nation with a high prevalence rate. However, in a society with high levels of unemployment and underemployment, the capacities of many people are already unused. Eliminating malnutrition will lead to improved capacities for many individuals, but will not necessarily lead to improved national productivity if they can not find work or simply replace work already being done by others (Hakim and Solimano, 1976).

Berg (1973:20) also notes the limited potential of improved nutrition in increasing national productivity in the face of heavy labor surplus. However, he suggests that there may be circumstances in which labor of adequate quality is limited. He also raises the question of whether malnutrition-reduced mental and physical capacities of small farmers might limit their ability to produce optimally, and especially to make use of new agricultural technologies. Stevens (1977) notes a number of potential benefits of increased worker productivity in developing countries, including particularly the "longer-run view".

Malnutrition is often viewed as having a major impact on two institutions at the national level, the educational and medical-care systems. In many developing countries there appears to be a high degree of wastage of public funds in education. This is partly due to a high level of school dropouts. A child who drops out before reaching functional literacy represents a waste of his/her teacher's efforts as well as other resources. In a Philippines study for the 1963-64 school year, the cost of this wastage was set at about 5 million dollars U.S. (Smart, 1972:15). The wastage caused by students who repeated grades (a repeater rate of 6.7%) was estimated to be nearly as high by the same study. In the Ivory Coast, over two-thirds of primary school children take at least one year and about one-third take at least two years longer than the usual time to complete primary school (Coombs, 1968).

Hakim and Solimano (1976) argue that improving the nutritional status of children is unlikely to increase the effectiveness and efficiency of school systems in most developing countries because schools seldom are attended by the lower income strata of the population, i.e. those most likely to be suffering from malnutrition.

Analogous arguments can be made with respect to the additional burden placed on health services by malnutrition. However, while the reduction of malnutrition in general probably would have disappointingly small beneficial effects on educational systems and medical services, the same cannot be said about the malnutrition caused by artificial feeding. This type of malnutrition is much more likely to occur in populations who are receiving social services, and to be absent from groups who do not have access to social services. Its relative impact on development may thus be much greater than that of malnutrition caused by other factors.

In the face of the numerous difficulties encountered in trying to estimate the cost of malnutrition, most efforts have been forced either to make a number of assumptions which are difficult to justify (e.g., Popkin, 1972; Selowsky and Taylor, 1973) or have had to concentrate on only those few of the costs which are easy to quantify (e.g., Cook, 1968 and 1971). The danger of the former is that the assumptions may be so incorrect that the findings are applicable to few if any real situations. The latter has the effect of grossly underestimating the true costs of malnutrition. Both are liable to be misused or applied inappropriately, simply because they stated in readily useable monetary terms.

In recognizing the inadequacy of currently available research, the temptation might be to reccomend that further research be done in hopes that some day the cost of malnutrition could be measured accurately in monetary terms. Call and Longhurst, however, do not feel that this deserves high priority. "Instead, the scarce research resources, money and brain power should be concentrated on other aspects of the nutrition problem...regardless of economic payoffs, attempts to solve the nutrition problem should have high priority, since they obviously affect the ability of individuals to survive within their society, alone a sufficient reason for high priority" (Call and Longhurst, 1972: 314). Until the various hypotheses relating nutrition to development have been adequately tested, "the only sound arguments for efforts to reduce malnutrition will continue to be ideological and ethical" (Hakim and Solimano, 1976: 251).

5. Goods cost of breastfeeding (G_{bf})

a. Calculation of food costs

Breast milk comes "ready-to-feed" and the equipment for its delivery is supplied free. Therefore, the only goods cost for breastfeeding is milk. The cost of this extra food can be calculated as the cost of an additional fraction of her customary diet (Heseltine, et al, 1966; McKigney, 1971a; Peterkin and Walker, 1976; Lamm, et al., 1977) or alternatively as the cost of a one- or two item supplement (Habicht, et al, 1975; Jelliffe and Jelliffe, 1975a). The former method tends to yield a higher cost for breast milk production than the latter, if less expensive foods are chosen. Increasing the amounts of one or two inexpensive foods is probably a more realistic alternative, especially under conditions where resources are scarce. If, for example, the typical diet consists of rice and a vegetable and meat sauce, a lactating mother might add some more rice, but she may be less likely to buy another tomato or a bigger piece of meat for the sauce.

If data from household food consumption surveys are available, relatively realistic figures for the cost of an additional fraction of a woman's diet may be readily calculated. However, when such data are not available, it is complicated and time-consuming to attempt to determine the cost of an additional portion of the mother's entire diet. Furthermore, it is doubtful whether this method will yield more accurate results than calculating the costs for a supplement of one or two typical foods. Basing the cost of the supplement on food prices rather than actual goods expenditures is likely to overestimate the real cost. This is because people with limited resources are likely to purchase selectively lower cost foods, paying great attention to seasonal variations. They may also bargain more successfully than the researcher or government employee gathering prices.

b. Energy needed for lactation

In determining the additional amounts of food required for lactation, the focus can be on calories. This greatly simplifies calculations without significantly reducing the validity of the estimate. There appear to be few adult populations who actually fail to obtain at least marginally adequate quantities of most nutrients, as long as sufficient quantities of energy are consumed. However, some attention should be paid to the protein adequacy of the diet if the staple food is a starchy fruit or tuber.

The number of careful studies on the caloric intake of lactating mothers is surprisingly small. The fragmentary pieces of information offered in most studies force conclusions to be rather speculative. Looking only at the number of calories ingested, it would appear that women in developed countries (Deem, 1931; Shukers, et al., 1932; Kaucher, 1946; Thomson, et al., 1970; Naismith, 1976) and women of middle to upper socioeconomic status in the Third World (Karmarkar, 1959), as a rule, receive enough calories to secrete sufficient quantities of breast milk. Caloric intakes of poor Third World women, on the other hand, sometimes appear to be so low that adequate lactation might seem to be an impossibility.

A study designed to determine the adequacy of energy intake for lactation should not only look at the number of calories ingested by the mother, but also view this in relation to her level of activity, her nutritional status, and that of her infant. However, as is apparent from Table 1, the focus in most research has been either on the caloric intake of the mother or the breast milk intake of the infant. Few studies have taken all the above mentioned factors into consideration.

A simple comparison of a mother's caloric intake with that of the lactating "reference woman" does not justify a claim that her caloric intake is inadequate. A seemingly low energy intake, i.e., low in relation to recommended daily intake for a lactating woman, may in fact be adequate if (1) the woman is small but of adequate nutritional status, and/or (2) her level of physical activity is low. Moreover, measurement of dietary intake is fraught with difficulty. The investigator may simply have failed to record the entire food intake.

But assuming that the energy intake of a woman is insufficient to cover her energy expenditure and to allow for adequate milk production, the latter may be kept up by temporarily depleting the woman's own body stores. Harrison, et al. (1975), using multiple regression analysis, found that body weight declined as duration of breastfeeding increased. However, there was no significant decrease of body weight as parity increased, indicating that the women were able to make up for the caloric deficit incurred during lactation at some other point in time. It has also been suggested that an adaptation to lower levels of many nutrients, including protein and calories, occurs in pregnancy and lactation (Jelliffe, EFP, 1976). Lactating rats on a low protein diet were found to utilize the protein more efficiently than nonlactating rats on the same diet (Naismith, 1976).

The danger of basing conclusions about the adequacy of a lactating mother's diet only on measurements of her caloric intake and/or her breast milk output can be illustrated with the uniquely detailed and complete data

TABLE 1: Variables measured in studies of caloric intake of lactating mothers and breast milk consumption of infants

Author Year	Mother's			Infant's	
	Calorie Intake	Level of Physical Activity	Nutritional Status	Breast Milk Consumption	Nutritional Status
Deem - 1931	X			X	
Shuckers et al. - 1932	X		X	X	
Wallgren - 1945				X	X
Kaucher et al. - 1946	X		X	X	(X)
Gopalan - 1958	X		X	X	X
Parischa - 1958	X				
Karmarkar et al. - 1959	X				
Rao et al. - 1959				X	(X)
Bailey - 1965				(X)	(X)
Becroft - 1967				X	
Thomson et al. - 1970	X		X		X
Martinez & Chavez - 1971			(X)	X	
Hanafy et al. - 1972				X	(X)
Rutishauser - 1974				(X)	
Blackburn & Calloway - 1976	X	X	X		
Lönnerdal et al. - 1976				X	
Lauber - 1977	X		X	X	X
Van Steenberger - 1977			X	X	X

Parentheses indicate that data are incompletely reported

gathered by Lauber (1977).* He followed four mothers and their infants in a rural area of the Ivory Coast through 19 months of lactation. The mothers' mean caloric intake for the entire period was 2042 kcal (±176). However, the mean at four months, the likely time of peak milk production, was 2486 kcal.**

The women, all near standard weight for height, weighed between 49 and 56 kg at one month of lactation. Their weights throughout the lactation period did not change markedly. Two women actually gained weight, 2.5 and 1.4 per cent of their original weights, while the other two lost 1.7 and 8.5 per cent. The woman whose weight decreased 8.5 per cent, however, showed no appreciable decrease in weight until around the seventh month of lactation.

The volumes of breast milk secreted appeared to be low. For example, at four months a mean of 460 ml was recorded. However, night feeds were not measured. Furthermore, the infants were thriving well up until the age of four months. In fact, they were even showing catch-up growth, as indicated by an increase in mean weight for ages from 89 per cent at one month to 97 per cent at four months.**

While Lauber's study underscores the deficiencies of other investigations, one cannot generalize from his results. The study included very few subjects--a shortcoming shared by most studies of this kind--and biological variation in human populations can be very large.

The FAO/WHO Handbook on Nutritional Requirements (Passmore, et al., 1974) recommends an additional 550 kcal per day for the first six months of lactation. Similarly, the United States Recommended Dietary Allowance (RDA) (NAS, 1974) suggests an extra 500 kcal. Recommended dietary intakes for lactating women in European countries vary from an additional 300 kcal in Hungary and 400 kcal in the Federal Republic of Germany, to an additional 1000 in Sweden, Finland, and the German Democratic Republic (Zöllner, et al, 1977). The U.N. and U.S. recommendations are based on an average daily output of 850 ml of milk, produced with 80 per cent efficiency, production being partially subsidized by fat stores laid down during pregnancy.

However, to compare properly the cost of the mother's diet with the cost of the breast milk substitute, the cost of all the calories needed to produce a given quantity of milk should be calculated. It is irrelevant for the calculations whether all the calories are consumed during the period of lactation or at some other time (i.e., derived from fat stores laid down before the birth of the infant and/or by creating a deficit to be replenished later).***

Recommendations for daily nutrient intakes are based on an 80 per cent efficiency of caloric conversion in the production of human milk. However, this is the lower limit suggested by Thomson, et al. (1970). The mean efficiency was reported to be 97 per cent. It would seem more appropriate in an economic analysis to use a value closer to the mean.

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*We are grateful to Dr. Lauber of the Nestle Foundation for sharing with us his original data.

**Calculated from Lauber (1977)

***This assumes a 100 per cent efficiency of conversion of energy into body stores. The actual efficiency in human beings is not known (Blackburn and Calloway, 1976), but is very high.

c. Breast milk intake

The amounts of milk consumed can be estimated either from reported measurements of breast milk intake or from calculations based on infant caloric requirements and standard body weights at given ages. Measurements of breast milk consumption would intuitively seem to be the more correct method. Also, caloric requirements are usually determined by studying artificially fed infants (Beal, 1970; Fomon, et al., 1971). However, most studies of breast milk production are plagued with a number of methodological problems, all of which tend to result in an underestimate of the true volumes being secreted. The "let down" or ejection of milk is a process which is easily inhibited by psychological stress. Measurements of milk output often take place at a clinic or in a hospital by so-called test weighings. The procedure of having her infant weighed before and after every feed coupled with being in an unfamiliar environment, may be very stressful for a mother. For example, when Swedish mothers were hospitalized only for the purpose of collecting their breast milk, their daily output fell by 210 ml (Carlsson, et al., 1976). Furthermore, for the convenience of the investigators, the weighings may be done at scheduled times. If the infant is otherwise fed on demand she or he may find it very frustrating not to be allowed to feed when she or he desires. When finally offered the breast, the infant may be so tired from crying that she or he takes less than the normal quantity. Also, the infant will probably spend less time at the breast, i.e., the breast will receive less stimulation from sucking, the key stimulus to milk production. Another problem with studies on breast milk production is that they often fail to measure accurately, if at all, the milk taken at night. Omolulu has reported that infants of traditional mothers in Nigeria may obtain over one-third of their intake of milk at night (Jelliffe, EFP, 1976). Van Steenbergen (1975 and 1977) found that between 7 pm and 7 am Kenyan infants between 1 and 23 months of age received about as many breast feeds as they did during the daytime. She test weighed infants before and after breast feeds at night and found a mean of 173 ml for 10 nights for 8 infants. (This was 50 ml more than the mean obtained simultaneously, using the "napkin method", which involved weighing the infant while wearing napkins and plastic pants before and after the night.)

Perhaps the best study of breast milk consumption was carried out on 363 healthy, fullterm infants in the 1930's by Wallgren (1945). Test weighings were performed at home by the mothers themselves, thus eliminating the problem of a stressful clinic or hospital environment. The mean weights of the infants corresponded closely to the standard weight at each age. The mean daily volume of milk consumed during the first four months was 722 ml (Table 2). A comparison with Table 3 shows that this agrees very well with the values obtained from calculations on caloric requirements (Beal, 1970; Fomon, et al., 1971) and standard body weights (Stuart and Stevenson, 1959). Thus, Walgren's findings appear to be valid and will be used in our calculations.

Beyond the age at which breast milk will no longer serve as the sole source of energy for an infant, but will have to be supplemented with other foods, breast milk production obviously cannot be estimated from calculations based on caloric requirements. It will be necessary to rely on studies of breast milk output. A compilation of studies which measured breast milk quantities is presented in Table 4. The table is designed to allow comparisons to be made among the studies in spite of the differing age categories used in

TABLE 2: Daily calorie intakes of normal infants, 0-4 of age, based on consumption of breast milk.

Age (months)	Volume of breast milk 1/ (ml)	Corresponding calorie intake for infant 2/ (kcal/day)	Calories needed by mother for milk production 3/ (kcal/day)
0-1	611	458	509
1-2	727	545	606
2-3	766	575	639
3-4	784	588	653
0-4	$\bar{x}$ = 722	$\bar{x}$ = 542	$\bar{x}$ = 602

Source: Wallgren (1945)

1/ Mean for both sexes. Adapted from Wallgren (1945)

2/ Based on a caloric concentration of human milk of 75 kcal/100 ml (Fomon 1974:362)

3/ Assuming an efficiency of milk production of 90 per cent (Thomson, et al., 1970)

TABLE 3: Daily calorie intakes of normal infants, 0-4 months of age, based on consumption of infant formula.

Age 1/ (months)	Weight 2/ (kg)	Caloric intake for infant 50th percentile (kcal/kg/day) 3/		(kcal/day)		Corresponding volume of breast milk 4/ (ml)	
		Beal	Fomon	Beal	Fomon	Beal	Fomon
0-1	3.9	115	116	449	452	599	603
1-2	4.7	131	111	616	522	821	696
2-3	5.4	116	99	626	535	835	713
3-4	6.0	107	95	642	570	856	760
0-4		$\bar{x}$ = 583		$\bar{x}$ = 520		$\bar{x}$ = 778	$\bar{x}$ = 693

Source: Beal (1970), Fomon, et al. (1971)

1/ Fomon reported age in 4-week rather than monthly intervals.

2/ The weights in the table were obtained by taking the mean of the standard weight at the lower and upper end of each age interval. Adapted from Stuart and Stevenson (1959).

3/ Values in the table represent means for both sexes. Adapted from Beal (1970) and Fomon, et al. (1971).

4/ Given a caloric concentration of human milk of 75 kcal/100 ml (Fomon 1974:362).

TABLE 4: Daily Volumes of Breast Milk Recorded from 0.5 to 36 Months of Lactation by Various Investigators

Age (months)	Daily volume of breast milk recorded (ml)							
	Gopalan[1] 1956 India	Rao et al. 1959 India	Becroft[1] 1967 New Guinea	Martinez and Chavez 1971 Mexico	Hanafy et al. 1972 Egypt	Rutishauser 1974 Uganda	Rajalakshmi[3] et al. 1974 India	Van Steenberger 1975 1977 Kenya
0.5	478			423				
1	497	530			768		470	535 730
2	472			577			600	
3	521	640	708		1030		660	453 745
4	483		858	537			740	
5	510	730	680	561	706	660	750	400 540
6							735	
7			666		912			
8		660						
9		600		462	843			
10			624					
11		525						
12								
13		515		444		606		405 470
14								
15								
16		440	695					
17			602					
18			588					
19			489	350		530		210 365
20		400	624					
21			638					
22			567					
23			567					
24								
30		425	482					
36			383					

1/ The volumes of breast milk, which were reported in ounces, were converted to ml, assuming 1 oz. = 28.34 ml.
2/ Values in the table represent the mean, at each age, for apparently healthy and malnourished mothers combined. Adapted from Hanafy, et al. (1972), by the present authors.
3/ Output is recorded in grams.

reporting the results. However, many studies had to be excluded because methodology was inadequate (as in most of the studies reviewed by Bailey, 1965:35) or data was inadequately reported (as in Oomen, 1961 and Blankhart, 1962) or not measured over a 24-hour period (as, apparently, it was not in Jansen, et al., 1960, Devadas, et al., 1973 or Svanberg, et al., 1977). Data on breast milk volume from a few other studies are reported by Jelliffe and Jelliffe (1978) but are not included here because the methodology of measurement is not described. Although breast milk output can often be underestimated (as discussed above), there are few ways in which it can be overestimated, other than random measurement error. Based on the studies summarized in Table 4, conservative estimates of mean daily outputs of milk would be 600 ml from 4 to 12 months, 400 ml from 12 to 24 months, and 300 ml beyond 24 months of age.

6. Goods cost of artificial feeding (G_{af})

The goods cost of artificial feeding includes not only food used to substitute for breast milk, but also costs for utensils, equipment, cleaning materials, fuel and water in order to achieve sanitary delivery of the milk to the infant.

a. Breast milk substitutes

In calculating the incremental economic value of breastfeeding over artificial feeding, breast milk must be compared to a product as similar as possible in its health-producing effects, or the value of breastfeeding will be underestimated (unless the value of the health loss of substitution could be included).

Commonly used artificial infant foods, usually modified cow's milk products, vary greatly in their health-producing effects. Among the six most commonly available types of milk, fluid cow's milk, dried skim milk, sweetened condensed milk, evaporated milk, full cream powdered milk, and infant formula, the first three can be considered unsatisfactory for use in infant feeding. In unmodified fluid cow's milk, the butterfat is poorly digested by young infants. This is also true of the protein, mainly due to the high concentration of casein, resulting in a high curd tension.* The high protein and mineral content lead to a high renal solute load which may put a stress on the young infant's somewhat immature kidneys, especially in a hot climate.

The problem of high curd tension is reduced in all forms of processed milk. However, the problem with renal solute load is increased in dried skim milk. Since the fat has been removed, the mineral and protein content per calorie is dangerously high for young infants. Dried skim milk can be used as a supplemental food (e.g., by adding it to porridge), but modification to a suitable infant formula in the home is relatively difficult. Sweetened condensed milk may or may not have its full fat content, but the level of added sugar is too high for it to be suitable for home modification to an infant formula (though Wheeler, 1974, suggests that it may be of value as a supplementary food).

Evaporated milk and full cream powdered milk can be more readily modified in the home for use as a breast milk substitute. They are often

*The curd tension is said to be high because a tough, rubbery curd, consisting mainly of casein and calcium, is formed when milk comes in contact with the hydrochloric acid of the stomach.

fortified with vitamin D and sometimes with vitamin A. However, since they are deficient in vitamin C and iron, supplemental sources of these nutrients must be given.

Infant formulas are modified and fortified with vitamins and minerals so as to serve as the sole source of food for an infant (though many may be somewhat deficient in various nutrients, especially iron). "Low solute" infant formulas are usually manufactured by replacing the butterfat with vegetable fats, removing the casein and adding demineralized whey, adding carbohydrate in the form of lactose, and adjusting the vitamin and mineral content to meet recognized standards.

It is technically possible to produce a non-milk-based artificial infant food capable of substituting satisfactorily for human milk. However, this would be too complicated and time-consuming to be feasible for home production, even if the ingredients were available locally. It would be misleading to compare the cost of such a food with that of breast milk, as if it could be readily used as a substitute.

b. Equipment

The following are the pieces of equipment that mothers should buy if they intend to bottle feed, according to midwives employed by two infant food companies in Ghana:

Company A	Company B
Table[1]	Table[1]
2 feeding bottles with teats	3 glass bottles
2 vacuum flasks[2]	1 vacuum flask
small plate with cover	bowl with cover
cup	cup
teaspoon	spoon
white cloth[3]	towel[4]
saucepan with cover	sponge, soap

[1]For baby bottle equipment

[2]One for porridge and one for water to mix with milk powder

[3]To cover the baby bottle equipment and keep off flies.

[4]For drying hands and utensils

The midwives of Company B estimated that about three bottles would break during the course of bottle feeding, i.e., a mother would have to buy a total of six bottles.

Habicht, et al., (1975), in calculating the cost of artificial feeding in Guatemala, assumed that a mother would have to purchase eight bottles

and that the bottle breakage rate would be one bottle per month. They also included the cost of a vacuum flask in their calculation. Popkin (1978) assumed that bottles would last for nine months, but did not indicate how many were used simultaneously.

c. Fuel

Habicht, et al., (1975) calculated the cost of heating and sterilizing bottles for one hour per day using gas or firewood. This would appear to be a reasonable estimate of the time required for proper heating and sterilization.

Electricity, gas or kerosene are often relatively inexpensive fuels. However, a substantial capital investment in some kind of stove is required before they can be used, and thus they are seldom used by low income families. Therefore, the fuel cost may be based more realistically on firewood or charcoal. Firewood (or wood for making charcoal) may be gathered at no monetary cost, at least in forest zones. However, in urban areas, and increasingly in many savanna areas, this is not possible (Eckholm, 1975; Sanger, 1976). Also, gathering wood may require a substantial expenditure of time and physical energy (which must be replenished with additional food), and thus is far from free in a broader economic sense.

7. Time cost of breastfeeding (T_{bf})

a. The importance of time as an economic variable

Economists think of the cost of an activity such as raising children as being composed of both a goods and a time cost. Child feeding, too, can be thought of in this way, but nutritional research often fails to take the time component into consideration. This may seem justified in the Third World, especially where there is little evidence of formal employment opportunities, at least for women. Time may seem of no consequence where there are no clocks, calendars, or appointments to be kept. But, in fact, people everywhere will choose the least time consuming way to accomplish a task, all else being equal. And time studies in many cultures show that women's time is more occupied with work than the men's.

This appears to be the case in Ghana, where Wegenbuur (1972) studied five husbands and their nine wives, all of whom were lime farmers. The five families, including large, medium-sized and small farmers, resided in the Western Region, and were observed for an entire year. The average time allocations of husbands compared to wives is shown in Table 5. It can be seen that the wives put in nearly as much time as the husbands in "productive activities," and so much more time in "household activities," (cooking, child care, etc.), that they had less time available for social activities, rest, and especially leisure.

Under such conditions, and they are probably rather common among low income groups, it is a serious mistake to ignore the importance of time. Many public health programs, in fact, assume that time is readily available for attending clinics, for preparing nutritious multimix foods, etc. Mellor (1975) points out that since middle and upper classes with leisure time benefit more from them than the poor, "such programs probably do serve to widen rather than lessen human welfare disparities".

TABLE 5: Time study of lime farmers in Ghana.

	Time spent (hours/months)										
	Productive activities*					Domestic activities					
	Farming	Non-Farming	Market	Sub-Total	Sleep	House-hold	Leisure	Rest	Med-ical	Social Obligations	Total
Husbands	113.75	36.48	9.34	159.57	262.71	64.19	103.18	59.27	6.02	64.96	719.92
Wives	102.94	21.18	17.64	141.76	266.52	171.48	48.20	40.48	5.85	45.64	719.93

*Includes time for preparation for activity and for walking to and from activity.

Adapted from:

Wagenbuur, H.T.M. (1972) Labour and Development. Social Science Research Project, Research Report Series No. 11, University of Cape Coast, Ghana.

b. Problems with measuring the value of time

Economists use the concept of "opportunity cost" to measure the value of a person's time. The opportunity cost for a person engaging in a certain activity is equal to the value of what that person could have accomplised if s/he had been free to use that time in another way. Popkin says that the "value of a person's time is based on the value of his/her marginal output at home or market activities" (Popkin, 1978:490), and Butz and Habicht (1976) add that opportunity cost also contains a social component. (For example, a mother might decide not to breastfeed because it is incompatible with enjoyable social activities).

Clearly it would seldom be possible to put a monetary value on the social component of an opportunity cost. Although the monetary value of household production is receiving increasing attention (see, for example, Gronau, 1973a and 1973b and M. Nerlove, 1974), it too is unavailable in most cases. Therefore, the actual or potential wage rate of a person is usually used as a measure of the value of his/her time.

The time component of child care costs when the mother remains at home might consist of (1) earnings foregone by diverting her time from paid employment to child care activities, and (2) changes in the stock of her "human capital" resulting from child rearing: (a) foregone additions to human capital (e.g., putting off further education) and (b) depreciation in existing human capital, as the mother's job skills become obsolete (Snyder, 1974:617). However, data is generally available only on foregone earnings. Since many women do not in fact forego paid employment to rear their children, their potential market wage rate is often estimated, based mainly on their level of education.

Actual or potential wage rate not only fails to measure a large component of opportunity cost, but it is also difficult to interpret in a realistic way both at the national and the family level. For example, it is clearly nonsense, in a society with high unemployment rate, to make a statement such as, "society is losing 10,000x dollars because 10,000 women with a potential wage rate of x dollars are caring for children rather than engaging in paid employment." It is even difficult to say that it is more costly to society when a woman with more education stays home to rear children, since in some developing countries, unemployment rates increase with increasing levels of education (Berg, 1973:21).

At the family level, one might expect that the higher the opportunity cost of breastfeeding for a woman, the less likely she will be to decide to stay home and breastfeed. But a woman with a higher wage rate or more education is also more likely to be married to a man who is earning enough so that she need not work many hours per day, if any, in order for the family's financial needs to be met. Conversely, the small earnings of a woman in the urban slums may be so crucial to the family welfare that she is forced to leave her baby behind and work.

Finally, there need be little or no opportunity cost of child care when a job is fully compatible with it. Brown (1970), in a study of several subsistence cultures, found that women tended to perform tasks compatible with child care. If the main economic activities available were compatible (i.e., relatively repetitive, interruptible, not dangerous to children, not requiring long distance travel), then women made a significant economic contribution to

the family. One implication of this is that women who live in a polygamous society where co-wives cooperate, or a society where day care centers are available can more easily choose jobs which are incompatible with child care.

c. Relationship between value of time and infant feeding practices

i. In Theory

Relatively little direct study has been made of the relationship between the value of a mother's time and how she allocates it to child care practices, let alone to infant feeding, which is only one component part. S.B. Nerlove (1974), in comparing a number of primitive cultures, found that women who started supplemental solid foods before one month of age made a greater contribution to subsistence activities. She did not include milk, which is more likely to replace breast milk than are solids. Furthermore, other important variables probably also correlated with this, so it is difficult to judge whether there was a cause and effect relationship (i.e., that women who participated more in subsistence activities supplemented earlier because their time was more valuable).

Nevertheless, the potential relationship between the value of a mother's time and her infant feeding practices has become a subject of increasing interest and speculation. Perhaps the best examples are the theories of Butz (1977). He suggests that during economic development there is a transfer of increasing numbers of functions from the home to specialized outside institutions, and an increasing proliferation of market-produced goods that substitute for human time in household production. "This process of specialization and the phsyical transfer of productive processes is at the center of -- may be the essence of -- economic development. It probably occurs in part because of long-term increases in the value of human time" (Butz, 1977:27).

Just as mothers come to use clothing stores, canned foods and electrical appliances in place of their own time, according to Butz' theory, they come to substitute commercial baby foods and contraceptives in place of the nutritional and birth spacing effects of breastfeeding. "Viewed in this way, the most effective solution in many situations is probably to work in league, rather than at cross-purposes, with the economic development process. If public policy can rapidly increase the supply of effective contraceptives and the hygienic, effective use of weaning foods, mothers will have the means to maintain and even increase their birth spacing and the survival and development of their infants. Ironically, the model developed here suggests that these policies will speed the breastfeeding declines at the same time that they make them irrelevant" (Butz, 1977:28).

This suggests that as development occurs, mothers find that there are more opportunities to engage in activities that are not compatible with breastfeeding. They are increasingly motivated to engage in these activities, and to do so they substitute artificial feeds in place of breast milk and someone else's time in place of their own for feeding their infant.

ii. In Ghana and the Ivory Coast

There are data suggesting that this sort of process may be occurring in Ghana. Vyas and Leith (1974) used multiple regression analyses to study differences in female labor force participation-rate among regions. They found

that (1) the average female earnings rate had no effect, (2) fewer women worked in regions with high unemployment, and (3) the greater a husband's income, the more likely a wife was to participate in the market labor force. The authors suggest that the third findings may indicate that there is substantial "substitutability" of a domestic servant's time for the mother's, and of market-produced goods for those produced at home. Thus, the greater the husband's income, the more these substitutes can be purchased, freeing the wife to participate in the labor force.

Several studies of infant feeding in Ghana have found a strong relationship between the educational background of the mother and her infant feeding practices. Harrington (1971) in a large study in 1965-66 found that educated mothers both in rural areas and in Accra stopped breastfeeding earlier, though the effect appeared to be stronger in Accra (Table 6).

Data from two rural villages in the Volta Region (Steckle, 1972), suggest that mothers with primary school education breastfeed for about as long as those with no education (median of about 24 months), but mothers with a middle school education stopped earlier (median of about 18 months) (Table 7).

Dovlo (1968) gathered data relating education to both breastfeeding and supplemental feeding in Accra. Table 8a presents data on the age of introduction of local supplemental foods. The father's education, likely to be a measure of family socioeconomic status, has no effect on age of introduction of these foods. However, mother's education, which, in addition to socioeconomic status could measure the value of her time, is associated with an earlier age of introduction. Table 8b shows that the father's education as well as the mother's is associated with the use of imported commercial infant foods. This would suggest that the use of these expensive foods, more so than local foods, is associated with an increase in income. The kind of foods included in the commercial foods category are more likely to be used to substitute for breast milk than are local foods. Thus, increased use of commercial infant foods might result in shorter duration of breastfeeding. This is in agreement with the data in Table 9, which also shows that each parent's education has a separate effect on the duration of breastfeeding (as was the case for the use of imported commercial infant foods).

In general, these data seem to support the hypothesis that a rise in the value of a mother's time (as measured by an increase in her education) may lead to the substitution of artificial feeding for breastfeeding. In addition, an increase in the father's education or occupational status is associated with an increased use of formula and decreased duration of breastfeeding, as the "substitutability" hypothesis of Vyas and Leith would predict.

One finding, however, appears to contradict somewhat Butz's hypothesis. This is Dovlo's data (Table 8a) showing that an educated mother introduced local foods earlier. This may in fact be the result of education specifically designed to encourage mothers to do so. But the preparation and feeding of local solid foods is very time-consuming, and based only on Butz's hypothesis, one would expect mothers whose time was more valuable to either add it later, or substitute timesaving commercial products for local ones (in fact, they probably do substitute to some degree, according to Dovlo's figures).

A similar picture emerges from studies done in the Ivory Coast. Two studies, Delormas, et al. (1974) and Dutertre and Paul (1974), have shown

TABLE 6: Duration of breastfeeding for children of educated versus uneducated mothers in Accra compared to rural areas of Ghana.*

Duration of breastfeeding (years)	Percent of mothers			
	Accra		Rural areas	
	Uneducated	Educated	Uneducated	Educated
< 1	34	59	22	29
1	38	32	29	28
1 1/2	16	7	14	18
2	12	2	17	14
≥ 2 1/2			18	2
Total	100	100	100	100
Estimated median (months)	14.5	10.2	17.8	15.5

*Estimated from data presented in Harrington (1971:191).
Based on samples of 4,549 births in Accra and 4,485 births in 21 rural villages.

TABLE 7: Duration of breastfeeding according to mothers' level of education in Vane and Jaupong, Volta Region, Ghana.

Duration of breastfeeding (years)	Level of Mother's Education					
	None		Primary		Middle	
	No.	%	No.	%	No.	%
≤ 1	5	8	2	7	2	11
1-2	27	43	14	47	12	67
2-3	25	41	13	42	4	22
≥ 3	5	8	1	4	0	0
Total	62	100	30	100	18	100

Source: Steckle (1972)

TABLE 8: Relationship between supplemental feeding and education of parents in Accra.

A. Introduction of local foods

Parents' education	Age of introduction of local foods (months)		
	Median*	Mean*	No.
Highly educated mother	3.5	4.7	10
Both parents educated	3.9	5.2	134
Only father educated	4.6	5.7	140
Neither educated	4.6	5.8	82
Total sample	4.3	5.5	366

B. Use of imported commercial infant foods

Infant food	Percent of families using commercial infant foods			
	Both educated (N=137)	Only father educated (N=156)	Neither educated (N=106)	Total sample (N=399)
Formula	47	31	15	32
Other milk	45	53	41	47
Flavored milk drinks	31	16	8	19
Cereal baby foods	12	4	4	7

*Calculated from data in Appendix II of Dovlo, 1968

Source: Dovlo, 1968

TABLE 9: Relationship between duration of breastfeeding and education of parents in Accra.

Duration of breastfeeding (months)	Both parents educated		Only father educated		Neither educated	
	No.	%	No.	%	No.	%
≤ 6	13	9	3	2	0	0
7-9	30	22	21	13	1	1
10-12	58	42	59	38	24	23
13-18	31	23	58	37	55	52
>18	5	4	15	10	26	25
Total	137	100	156	100	106	100
Mean	12.0		14.1		17.8	
approximate Median*	10.6		12.3		15.1	

*Calculated from data in Appendix I of Dovlo (1968)

Source: Dovlo, 1968

that the ability to comprehend French (a measure of level of education and/or occupation) among Abidjan mothers was significantly associated with (a) earlier weaning (Table 10), (b) earlier introduction of cereals (Table 11), and (c) initiation of mixed or artificial feeding (Table 12). Sieye (1975) found that Abidjan mothers with more formal education weaned earlier, and that the higher the employment status of the father, the greater was the chance of the child being weaned "prematurely".

It must be stressed that, although these findings do not seriously contradict the hypotheses put forth by Butz (1977), and by Vyas and Leith (1974), they cannot be used to prove the hypotheses. Firstly, levels of parental education and income correlate with and can serve as measures of a number of variables besides the value of time, e.g., contact with Western ideas and advertising. Secondly, the studies are all cross-sectional and thus do not actually measure the effects of change.

d. Factors which mitigate the opportunity cost of breastfeeding

Butz's hypotheses could explain a decline in breastfeeding only if women in fact perceive breastfeeding as having a high opportunity cost. At first glance, breastfeeding may appear to be uniquely inflexible: either the mother remains bound to the infant, seemingly unable to carry out any (other) economically meaningful activities, or the infant must be artificially fed. In fact, there are a number of factors which tend to decrease the true opportunity cost of breastfeeding:

(1) In many traditional cultures, temporary wet nursing by relatives or co-wives can help maintain lactation and the baby's health if mother and baby have to be temporarily separated or the mother falls ill. In industrialized countries, supplementary artificial feeding is often attempted for the same purpose.

(2) Young children in the Third World commonly sleep with their mothers at night and breast feed without taking any of their mother's time at all. In Ghana, Grant (1955b:699) noted that this is practiced until after the child is weaned. In the infant feeding time study discussed below, 8 of 10 breastfeeding mothers in Accra said that they did sleep with their infants.

(3) Breastfeeding is not incompatible with many economically important activities. It need not occupy both arms or the full attention of the mother, especially once the child is old enough to take the breast him/herself. Berg (1973:97) noted that rural West African women commonly conduct business or even walk carrying head loads while their infants breast feed. Kaye (1960), summarizing reports from over 20 child care studies in Ghana, cited a number of examples of this. One report stated, "When the child is old enough to stand, it may feed itself from the breast while its mother gets on with her chores."

(4) There appears to be a broad range of economically productive activities available to Third World women which are relatively compatible with breastfeeding. These include a variety of agricultural activities, retail marketing or trading, and numerous "cottage industries" which can be carried out in the home or an informally run workplace near by. Moreover, jobs which are less compatible with breastfeeding, usually those in the industrial sector, are scarce in most Third World countries, particularly for women.

(5) The mother and infant need to be together all day only during the period of exclusive breastfeeding. This period varies greatly in practice,

TABLE 10: Relationship between weaning age and mother's knowledge* of French in Abidjan.

Age of child (months)	Children weaned: Mother knows French				Mother does not know French			
	Delormas et al.		Dutertre and Paul		Delormas et al.		Dutertre and Paul	
	N	%	N	%	N	%	N	%
0-8	161	10	163	8	1	122	72	1
9-14	127	17	93	24	4	78	61	5
15-17	19	42	65	57	25	16	35	14
18-20	23	83	45	84	54	24	33	55
21-23	16	75	42	86	67	24	35	77
24-30	20	85	--	--	96	24	--	--

Source: Calculated from data presented in Delormas et al. (1974:24) and Dutertre and Paul (1974:83).

*Delormas et al. (1974) refer to the ability to "comprehend" French and Dutertre and Paul (1974) to the ability to "speak" French.

TABLE 11: Relationship between age of introduction of cereals and mother's knowledge* of French in Abidjan.

Age of child (months)	Children supplemented with cereal							
	Mother knows French				Mother does not know French			
	Delormas et al.		Dutertre and Paul		Delormas et al.		Dutertre and Paul	
	N	%	N	%	N	%	N	%
5	75	45	101	41	55	24	37	19
6	204	90	114	96	135	79	62	90

Source: Calculated from data presented in Delormas et al. (1974:42) and Dutertre and Paul (1974:51).

*Delormas et al. (1974) refer to the ability to "comprehend" French and Dutertre and Paul (1974) to the ability to "speak" French.

TABLE 12: Relationship between practice of mixed or artificial feeding (all ages combined) and mother's knowledge* of French in Abidjan.

	Mother knows French		Mother does not know French	
	Delormas et al. N=242	Dutertre and Paul N=210	Delormas et al. N=159	Dutertre and Paul N=96
Per cent exclusively breast fed	47	67	86	95
Per cent mixed or artificially fed	53	33	14	5
	100	100	100	100

Source: Calculated from data presented in Delormas et al. (1974:16) and Dutertre and Paul (1974:42).

*Delormas et al. (1974) refer to the ability to "comprehend" French and Dutertre and Paul (1974) to the ability to "speak" French.

but a number of factors (Jelliffe and Jelliffe, 1975b) suggest that four to six months is the ideal. Once supplementation has been started, the mother can more easily be separated from her baby for a portion of the day. Even mothers who must work distant from home all day are able to practice breastfeeding at night, in the mornings, and during week ends. Thus the data in Table 13 show that, although Philippine mothers who work in distant barrios practice less exclusive breastfeeding, they practice more mixed feeding (breast plus artificial), so that there is little effect of location of work place on total proportion of babies receiving at least some breast milk.

(6) Even the conflict between breastfeeding and market employment of the mother can be minimized with appropriate legislation and other measures. The International Labor Organization Convention No. 103 Concerning Maternity Protection (revised, 1952) specifies that women employees should be entitled to at least 12 weeks maternity leave, not less than 6 of which are to be taken after confinement. They are to receive renumeration during this period of not less than two-thirds of their previous salary, to come from compulsory social security or public funds. To the extent that employers are asked to contribute to such funds, this should be on the basis of total number of employees, irrespective of sex. Women employees who are breastfeeding are entitled to breaks for this purpose, to be counted as working time.

In Ghana, the Labour Decree of 1967 provides the above described leave at a minimum of 50% of wage. Two half-hour nursing breaks are allowed to breastfeeding mothers once they have returned to work (Greenstreet, 1971:120). However, there is a severe shortage of day care centers in Ghana (Piel, 1972), so mothers who live far from home cope by combining their breaks and rushing home from work one hour early to breastfeed.

The Ivory Coast ratified ILO Convention No. 3, the predecessor of No. 103 described above (Korchounova, 1978). Ivorian women have the right to a maternity leave of 14 weeks, which can be prolonged for up to 3 weeks. They also have the right to a one-hour break each day throughout 15 months of breastfeeding. The law assumes that women should interrupt their work 6 weeks before delivery and resume again 8 weeks afterwards. Employers with more than 20 female employees are obliged to prepare a special room for breastfeeding infants (Ministere de la Condition Feminine, 1975).

e. Past research on time required for breastfeeding

Few studies have actually measured the time spent in breastfeeding. Popkin and Solon (1976:1) cite studies showing that Filipino infants breastfeed seven to eight times per day, with each feed lasting from 15 to 30 minutes. In one rural area of the Philippines, Popkin (1978:494) reports time spent on breastfeeding by 33 mothers. Counting time actually spent holding the child, he found that the poorer mothers spent a mean of 68.6 minutes per day breastfeeding, while among richer mothers the figure was 116.3 minutes.

In rural Mexico, Chavez, et al. (1975:98) followed 17 non-supplemented and 7 matched supplemented mothers and their infants longitudinally from 14 to 250 days of life. Five measurements of breastfeeding time were taken periodically during this period, each of 72 continuous hours' duration. "Long resting periods within feeds" were included (Martinez and Chavez, 1971:147). The total time spent breastfeeding varied from 100 to 220 minutes per day among various groups.

TABLE 13: Association between breastfeeding of children under 2 and location of mother's occupation for rural areas (Philippines)

Method of feeding
(%)

Location of Occupation	Rural Coastal None*	Only Breast	Only Bottle	Mixed	Total Breastfed	Rural Hinterland None*	Only Breast	Only Bottle	Mixed	Total Breastfed
No occupation	10	70	6	14	84	7	78	10	5	83
In home	0	75	13	12	87	0	88	0	12	100
In same barrio**	16	77	0	17	94	20	60	20	0	60
Different barrio	0	43	14	43	86	17	50	17	16	66

Number of cases = 139.

Source: Adapted from Popkin, B. M. and Solon, F. S. (1976) Income, Time, the Working Mother and Child Nutriture. J. Trop. Ped. 22: 156. A column headed "Total" was replaced with the one headed "Total Breastfed".

* The meaning of this category is not explained in the original paper.

** The percentages for "Rural Coastal" add up to 110% for this category in the original paper.

In rural Kenya, Van Steenburger (1975, 1977) observed breastfeeding of infants aged 1-23 months, with results as reported in Table 14. Whereas Chavez et al. (1975) reported a negative correlation between the amount of time spent breastfeeding and the amount of milk produced, the generally longer mean sucking times found by Van Steenburger in 1977 than in 1975 (Table 14) were usually associated with greater mean milk volumes (Table 4).

Grant (1955b:696) found that during observation periods of one to one and a half hours, Ghanaian infants breast fed three to four times, but for short periods of less than five minutes each. This is closer to the often observed situation where the breast appears to serve as a comforter as well as a source of nourishment (Jelliffe and Bennett, 1975).

There are additional time-consuming activities potentially associated with breastfeeding. The additional food eaten by the mother to produce breast milk requires time to obtain, prepare, and eat, although in most cases, this addition will result in negligible increases beyond normal activities. There may for some women be a small time expenditure on breast and nipple preparation and treatment for pains and ailments associated with breastfeeding. Although breastfeeding is an instinctive activity in animals, opinions vary as to whether this is true in human beings (see Helsing, 1976 and subsequent discussion). In traditional cultures breastfeeding may be learned as a matter of course, first as a girl grows up observing others breastfeed, and later within the normal social situations which surrounds a new mother (Raphael, 1973). When this is lacking, as in some urban settings, some intentional training and counseling of a mother is probably necessary if breastfeeding is to be successful. There does not appear to be any research documenting the time spent on these activities.

8. Time cost of artificial feeding (T_{af})

The time required for artificial feeding is a more complex issue than that needed for breastfeeding, because more persons and more activities are involved in artificial feeding. The various activities involved in artificial feeding are discussed below.

a. Obtaining goods

The time required for obtaining the goods inputs for artificial feeding may be large in a low income setting, especially if it is rural. Simply purchasing milk on a continuing basis may require much time if the distance to the sales outlet is great and the capital necessary to purchase large quantities at once is lacking. The time input will be high also in situations where availability of infant foods is restricted. In Guinea Bissau and Papua New Guinea, infant feeding bottles and infant formula are sold only in pharmacies to those with a doctor's prescription. In the Ivory Coast, too, infant formula is sold only in pharmacies, though a prescription is not required. In Ghana, where lack of foreign exchange has led to restricted imports of infant foods (as well as other commodities), infant formula is very time consuming to obtain. Most mothers must wait long hours in line with the weight chart for their infant from the local clinic, each time they to obtain one tin.

While some of the goods inputs take time to obtain only once (e.g., stove, pan, sterilizer), or occasionally (e.g., bottles and nipples), others, such as additional fuel and water, must be replenished frequently.

TABLE 14: Breastfeeding time in a rural area in Kenya

	Age (months)									
	1-2		3-5		6-11		12-17		18-23	
	1975	1977	1975	1977	1975	1977	1975	1977	1975	1977
Sample size	7	12	8	7	10	15	16	14	6	7
Mean number of feeds ± Std. dev. (7am-7pm)	5.0±0.7	6.7±1.4	4.3±1.4	5.7±1.4	4.4±1.1	3.9±1.8	3.1±1.4	3.0±1.0	2.3±1.0	3.4±1.2
Mean suckling time (min) per feed	11.4	13	10.8	16	11.7	12	10.7	11	11.5	15
Total suckling time (min) (7am-7pm)	57.0	87.1	46.4	91.2	51.5	46.8	33.2	33.0	26.5	51.0

Source: Van Steenbergen, 1975 and 1977

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The amount of water needed to wash and rinse utensils properly and repeatedly for artificial feeding is probably fairly large. Among low income people water is often difficult to obtain and tedious to carry home. In the Philippines, Popkin (1976:8) found that, while those with private water supplies travelled an average of 8 meters, and used 8.4 minutes of time per day to obtain water, those without private supplies travelled an average of 181 meters, requiring 27.4 minutes per day to obtain it. Women in two villages in the Ivory Coast spent 15 and 20 minutes per day procuring water (Burnier, 1972). Even in Abidjan, only 5% of families have indoor water taps, and another 25% have taps in their yard (Duponchel, 1971:216). A sample of women in southeast Ghana spent 46 minutes per day obtaining water (Dalton and Parker, 1973).

Fuel, too, is difficult to obtain in many areas, and artificial feeding, demanding boiled water for feeds, and clean utensils, would significantly increase the need for fuel. Those who cannot afford to buy and kind of fuel, let alone more convenient forms such as gas, oil, kerosene, coal, or charcoal, must gather it. In some areas this requires a great deal of time and energy.

b. Education for artificial feeding

The skills required to prepare artificial feeds which are nutritionally adequate and hygienically safe are relatively abstruse. This is especially true for feeds for young infants. The time required to impart these skills to a mother increases with decreasing levels of maternal literacy, familiarity with modern or Western concepts, intelligence, and familiarity with the germ concept of disease.

In Ghana, nurses employed by two of the proprietary infant food companies were asked how long it took them to impart the skills required for proper artificial feeding. Nurses from one company said that only a one day training session was needed for educated mothers (who commonly had some training in bottle feeding in middle school). A week of day long sessions would be needed if illiterate village women were to be properly trained. A nurse from another company estimated that one week of private 30 minute sessions were necessary for well-educated mothers, while she needed one to three months of sessions for illiterate mothers. Training in groups would probably take longer (requiring less of the nurse's time per trainee, but more of the mothers' time for the same skills to be learned).

c. Preparation of feeds

Convenient, but extremely expensive equipment and foods can be used by relatively wealthy mothers to save time in the preparation of artificial feeds. Low income mothers usually can afford only one or two bottles and must prepare each feed individually from powdered formula.

d. Washing and sterilizing utensils

Washing and sterilizing utensils is very time-consuming, especially when running water is not available, and only one or two bottles are possessed. Although there are several methods for reducing bacterial contamination to safe levels, the safest and least expensive in terms of required equipment are also the most time-consuming.

e. Feeding the infant

The time needed to artificially feed the infant will depend on the method used and the infant's age. Cup and spoon feeding is often recommended in situations where bottles, because they are more difficult to clean, are likely to be more contaminated. But cup and spoon feeding is extremely tedious and time-consuming. Some mothers reduce the time required for bottle feeding by cutting wider the hole in the nipple, especially if it is to be used for feeding porridge from the bottle.

f. Disease

The disease-producing effects of artificial feeding are discussed beginning on page 10. Disease, including malnutrition, can be extremely costly in terms of time, not only for the sick person, but for those who must care for him/her. Even for an infant there is a time cost of disease, due to potentially important learning experiences being missed. A busy parent must devote much additional time to the care and feeding of a sick child. When the disease is serious, it may result in sleepless nights for the parent, possibly leading to reduced productivity the next day on the job. Transportation to a clinic or hospital may take a long time, and the time spent in waiting rooms is legendary. Many hospitals in the Third World will not admit an infant unless her/his mother stays with her/him. Most nutrition rehabilitation centers require that the mother accompany the child during his/her recuperation, or at least spend several hours per week at the center (though the mother may receive lodging or food and presumably some education in return for her input of time and labor). If the infant dies, the entire time invested in that infant's care and feeding is lost, as well as additional time for the burial and mourning. From the viewpoint of society as a whole, the time of the limited staff of health professionals is a very valuable and scarce commodity. A commonly found situation is that so much of their time is taken by curative duties that none is left for preventive medicine.

g. Past research on time required for artificial feeding

This has received even less attention than time required for breastfeeding. Popkin (1978:494) observed bottle feeding in a sample of 17 families in rural Philippines. Among the poorer families, bottle feeding required 22 minutes per day, and among the richer, 29.1 minutes per day (this included only the time during which the child was held).

The value of this time was calculated by measuring the proportion spent by each family member and estimating each person's actual or predicted wage rate. Table 15 shows the resulting data.

III. RESULTS FROM THE IVORY COAST AND GHANA

In the following sections, an attempt is made to estimate, as accurately as possible, the incremental economic value of breastfeeding in the Ivory Coast and Ghana. In most instances the methods used are described in detail in hopes that they may be of value in making such estimates for other countries.

TABLE 15: Private costs per day for bottle feeding in rural Laguna, Philippines

	Poor	Rich
Daily costs of milk	₱ .91	₱ 1.23
Costs of feeding utensils[1/]	₱ .014	₱ .02
Total money costs	₱ .924	₱ 1.25
Bottle feeding time[2/] - minutes per day		
Mother	11.5	13.9
Father	6.2	2.3
Children	4.3	2.6
Other relatives	.0	10.3
Wage rate-peso per hour		
Mother	₱ .52	₱ 1.80
Father	₱ 1.98	₱ 4.08
Children	₱ 1.64	₱ 1.73
Other relatives	₱ 1.38	₱ 2.54
Total time costs	₱ .42	₱ 1.08
Total costs	₱ 1.23	₱ 2.31

Source: Popkin, 1978

1/ Based on use for 270 days. Prorated for daily costs. Only bottles were purchased.

2/ Total bottle feeding times for the poor and rich are 22 minutes and 29.1 minutes, respectively. The 17 families observed fed children in all age groups. The actual time holding the child is counted.

In any exercise such as this, lack of data is a difficult problem. In some cases this can be best dealt with by making estimates or educated guesses. In other cases, the best approach is to utilize data from a similar country, modifying them as appropriate. This was felt to be particularly applicable here because of the high degree of similarity between Ghana and the Ivory Coast.* Therefore, estimates are based on reliable data from the other country in some cases, in preference to mere guesses based on incomplete data from the country in question. Thus the major work for goods costs was based on data from the Ivory Coast, and time costs were based on data from Ghana.

A. Ivory Coast (See Appendix IV)

1. Individual Level Analyses

a. Goods cost of breastfeeding

i. Method

Most of the methodological issues were discussed on pages
The following calculations assume that breast milk is produced from the calories the mother consumes with an efficiency of 90%. Breast milk will be assumed to be the sole source of energy for the first four months, in the quantities shown in Table 2. Based on the data in Table 4, breast milk intake thereafter will be assumed to be 600 ml from 4-12 months of age, and 400 ml from 12-24 months. Calculations are based on breast milk production only up through 24 months of age.

In the absence of recent data for the Ivory Coast on household food consumption and expenditure, the cost of extra food for the lactating mother is based on an additional supplement to her diet of commonly eaten foods. The typical diet in the Ivory Coast consists basically of a starchy staple served with a sauce made from vegetables and meat or fish. Small scale nutrition surveys in the village of Kpoebe** showed that besides a starchy staple (usually foutou***) and sauce, few other foods were eaten (Lauber, 1977). The starchy staple and sauce are prepared for the main evening meal and leftovers are eaten in the early morning and around noon the following day. Thus, calculating the cost of the extra calories needed for lactation based on an extra portion of a starchy staple with sauce will be almost equivalent to calculating the cost as a fraction of the mother's entire diet.

Calculations are based on an extra serving of either foutou and peanut sauce or of rice and peanut sauce. Rice is chosen as the second alternative

*Although Ghana and the Ivory Coast have different colonial backgrounds, and thus different national languages, their mutual boundary is not a natural one. Thus portions of both countries share a similar pre-colonial history and culture. They are similar geographically and ecologically, with many agricultural and dietary patterns in common. Their levels of development are roughly similar, Ghana having 28.9% and Ivory Coast having 31.4% urban population (Persons residing in communities with over 5000 inhabitants; from de Graft-Johnson (1974) and Ministere du Plan-Abidjan (1976) respectively).

**Kpoebo is situated 130 km north of Abidjan, in the transition zone between forest and savannah.

***Foutou is made from yam, plantain, or a starchy vegetable which is boiled, then pounded to a smooth paste and shaped into balls.

mainly because it has a stable price that does not vary much with season or location. Also it is becoming increasingly popular throughout the Ivory Coast. Peanut sauce was one of the two sauces for which detailed recipes could be obtained.* Based on data provided by Lauber (1977) on the weights of foutou and sauce for a total of 60 meals for four women, the ratio of foutou to sauce was calculated to be 4.2 to 1. The proportion of rice to sauce was assumed to be the same as for foutou and sauce.

Prices for various foods were obtained from the Ministry of Planning. Market prices are reported for Abidjan, Abengourou, Bouake and Korhogo, which are all towns with over 30,000 population (Ministere du Plan, 1976). Thus, they are at best representative of large urban areas in the Ivory Coast. By excluding the capital city, Abidjan, where pricing may be influenced by the large number of expatriates, the data from the other cities were felt to be somewhat more representative of the entire country. The calculations are thus based on average prices for Abengourou, Bouake and Korhogo for all of 1976.

The cost per 100 kcal of foutou, rice, and peanut sauce was calculated. The amount of protein and the weight of food were included, the latter to ensure that the size of the portion would not be unduly large. A detailed account of how the figures were arrived at is given in Appendix I.

The daily extra food cost was then calculated by multiplying the cost per 100 kcal times the number of extra calories needed for lactation at each age interval.

ii. Results

Table 16 gives the cost, protein content and weight per 100 kcal of foutou and peanut sauce and of rice and peanut sauce. The daily cost of the extra food for a lactating mother, i.e., the goods cost of breastfeeding, is presented in Table 17. For a food supplement of foutou with peanut sauce, the average daily cost is US $0.14 and the cost for the entire two-year period is US $102.20. If the peanut sauce is instead eaten with rice, the average daily cost is US $0.07 and the total cost for the two years is $51.10.

b. Goods cost of artificial feeding

i. Method

Prices were collected for various type of milk available in Abidjan as of May, 1977. For each type of milk, the mean cost of all sizes and brands was calculated.

In calculating the incremental economic value of breastfeeding over artificial feeding, breast milk must be compared to a product as similar as possible in its health-producing effects, or the value of breastfeeding will be underestimated (unless the value of the health loss of substitution could be included).

*Detailed recipes for the most commonly eaten sauces in Kpoebo are reported by Burnier (1972). Each recipe is an average based on observations of at least five preparations. Lauber (1977) chemically analyzed sauces from the same village a few years later. These two sources of data agreed well for peanut sauce and for okra sauce. Peanut sauce was chosen because of its higher concentration of calories and protein.

TABLE 16: Cost, protein content, and weight per 100 kcal of extra food for a lactating mother in the Ivory Coast, May 1977.

Food	Cost		Protein	Weight
	FCFA	US$	(g)	(g)
Foutou	6.8	0.028	2.1	141
Rice (cooked)	2.8	0.012	1.8	92
Peanut sauce	10.0	0.041	7.6	102
Foutou and peanut sauce	7.6	0.031	3.2	99
Rice and peanut sauce	3.9	0.016	2.9	94

US$ 1 = FCFA 242

Source: Appendix 1.

TABLE 17: Cost of extra food for lactating mother in the Ivory Coast, 1977.

Age of child being breast fed (months)	Energy for breast milk production kcal/day	Daily cost of foutou and peanut sauce 1/ FCFA	US$	Daily cost of rice and peanut sauce 2/ FCFA	US$
0-4	602 3/	45.8	0.19	23.5	0.09
4-12	500 4/	38.0	0.16	19.5	0.08
12-24	333 5/	25.3	0.10	13.0	0.05
mean: 0.-24	433.5	32.9	0.14	16.9	0.07

US $ 1 = FCFA 242

1/ Cost: 7.6 FCFA/0.031 US $ per 100 kcal (Table 16)

2/ Cost: 3.9 FCFA/0.016 US $ per 100 kcal (Table 16)

3/ Mean for the first four months (Table 2)

4/ Based on a breast milk output of 600 ml, assuming 90% efficiency of production (Thomson, et al., 1970)

5/ Based on a breast milk output of 400 ml assuming 90% efficiency of production (Thomson, et al., 1970)

In the calculations which follow, two alternative approaches are used. For Alternative A, low solute infant formula is used as the substitute for breast milk in calorically equal quantities throughout a period of 24 months of breastfeeding. Because infant formulas are so expensive, Alternative B uses low solute infant formula for only the first four months (when the infant is especially vulnerable to health problems caused by less suitable forms of milk). Full cream powdered milk is used for the next 20 months, also substituting for breast milk in calorically equal quantities. Powdered milk is the type usually given to young children in the Ivory Coast (Delormas, et al., 1974:27). Also, full cream powdered milk is more appropriate for infant feeding than the other low cost types of milk.

The daily cost of artificial infant food was calculated based on the cost per 100 kcal for each alternative and the number of calories to be substituted at each age interval.

It could be argued that if artificial feeding is to substitute properly for breastfeeding, the equipment should be chosen so as to ensure the preparation of a product as hygienically safe as breast milk. This may mean that a refrigerator, a gas or electric stove, a bottle sterilizer and a large number of bottles would be needed. However, this is clearly unrealistic for low income mothers. Therefore, calculations are based on a minimal quantity of equipment, six bottles (three for concurrent use plus three for replacements), one vacuum flask (for keeping boiled water), and one extra pot (for boiling water and sterilizing bottles). The cost of bottles is prorated over one year, assuming that bottle feeding lasts about that long before a cup is introduced. The vacuum flask and the pot, however, will continue to be used throughout the period of artificial feeding. These costs are therefore prorated over two years.

Habicht, et al., (1975) calculated the cost of heating and sterilizing bottles for one hour per day using gas or firewood. This would appear to be a reasonable estimate of the time required for proper heating and sterilization.

Electricity, gas or kerosene are often relatively inexpensive fuels. However, a substantial capital investment in some kind of stove is required, and thus they are seldom used by low income families. Therefore, the fuel cost may be based more realistically on firewood or charcoal.

Calculations were based on charcoal, since a more precise estimate could be made of the cost of using it. Based on the cost for a sack of charcoal, and the range of time over which it would provide cooking fires, the cost of charcoal for one hour in Abidjan ranged from US $0.24 to $0.36. The fuel cost for the entire country was calculated by using the lower of these figures, and assumed that the rural 70% of the population gather most of their fuel and thus pay only 25% as much for fuel as urban dwellers. Time costs for fuel in rural areas were increased correspondingly.

Finally, the total daily goods cost of artificial feeding was obtained by adding together the costs of artificial infant food, equipment and fuel.

ii. Results

The costs per 100 kcal of different types of milk in Abidjan are

TABLE 18: Cost of Various Milks in Abidjan, Ivory Coast in May, 1977.

Type	Brand[1]	Cost FCFA/100[2]	Cost FCFA/100kcal[3]	Mean cost per 100 kcal FCFA	Mean cost per 100 kcal US $
Low solute infant formula				23	0.095
	Nan	117	23		
	Nativa	110	21		
	Similac	130	25		
Dry sweetened milk (infant formula)				19	0.079
	Nido 1/2	79	19		
	Nido 1/1	82	17		
	Guigoz 1/2	88	21		
	Guigoz 1/1	92	20		
Full cream powdered milk				14	0.059
	Nestle	67	14		
	Klim	64	13		
	Gloria	73	15		
	Bebe Hollandais	53	11		
	Lita	50	10		
	Laicran	55	11		
	Celia	54	11		
	Farm	48	10		
	Quick lait granule	110	22		
Dry skim milk				21	0.087
	Gloria	71	19		
	Regilait	84	23		
Evaporated milk				16	0.066
	Gloria	23	17		
	Lita	21	15		
	4-Vaches	18	13		
	Farm	22	16		
	Coast	21	15		
	Bonnet Rouge	27	20		
Sweetened condensed milk				10	0.040
	Nestle	35	11		
	4-Vaches	31	10		

TABLE 18: (Continued)

Type	Brand[1]	Cost FCFA/100g[2]	Cost FCFA/100kcal[3]	Mean cost per 100 kcal FCFA	Mean cost per 100 kcal US $
Sweetened condensed milk (cont.)				10	0.040
	Bonnet Rouge	32	10		
	Bebe Hollandais 1/1	31	10		
	Gloria	31	10		
	Tatra	21	7		
	Farm	27	8		
	La Tour	28	9		
	La Paix	28	8		
Fluid milk				25	0.105
	Gloria 1/1	15	23		
	Gloria 1/2	14	29		
	Bebe Hollandais 1/1	26	40		
	Princes 1/1	13	20		
	Princes 1/2	12	24		
	Laidor 1/2	11	22		
	Bridel 1/1	14	22		
	Bridel 1/2	13	27		
	REK 1/2	12	24		
	Nestle 1/1	14	22		
	Snoopy 1/1	14	22		

US$ 1 = FCFA 242

1/ Full cream milk is designated with the symbol 1/1. Half cream is 1/2.

2/ Prices were obtained from five supermarkets in Abidjan and from a price list supplied by Nestle (CAPRAL), Abidjan. For each kind of milk, the mean cost for all size containers for each brand was calculated.

3/ Given the following caloric concentrations (kcal/100gm): NAN, 506; Nativa, 520 (Nestle product information). Similac, 520 (assumed to be the same as Nativa, since caloric concentrations for the reconstituted products are identical); Nido 1/2, 426; Nido 1/1, 470; Guigoz 1/2, 424; Guigoz 1/1, 461 (Nestle product information). Full cream powdered milk, 502; dry skim milk, 363; evaporated milk, 137; sweetened condensed milk, 321; fluid whole milk 1/1, 65 (Items #1326, 1327, 1324, 1325, and 1320 respectively in Watts and Merrill, 1963). Fluid half cream milk 1/2, 49 (estimate based on fat content of 1.7%).

TABLE 19: Cost of Artificial Infant Food

Age of infant (months)	Energy from breast milk kcal/day	Daily cost of Alternative A 1/ FCFA	US$	Daily cost of Alternative B 2/ FCFA	US$
0-4	542 3/	124.7	0.515	124.7	0.515
4-12	450 4/	103.5	0.428	63	0.260
12-24	300 5/	69	0.285	42	0.174
mean: 0-24	390.3	89.8	0.371	62.8	0.260

US$ 1 = FCFA 242

1/ Breast milk is substituted by low solute infant formula (0-24m). Cost: 23 CFA/US$ 0.095 per 100 kcal (Table 18).

2/ Breast milk is substituted by low solute infant formula (0-4m) and dry whole milk (4-24 m). Cost for the former see above; cost for the latter: 14 FCFA/US$ 0.059 per 100 kcal.

3/ Mean for the first four months (Table 2).

4/ Based on a breast milk intake of 600 ml (see page 23).

5/ Based on a breast milk intake of 400 ml (see page 23).

TABLE 20: Cost of Equipment for Artificial Feeding

Item	Price/each FCFA	Quantity	Total Cost FCFA		Cost per day FCFA	US$
Bottle(plastic)	835[1/]	6	5010		13.7[3/]	.057
Thermos	1645[1/]	1	1645			
				2845	3.9[4/]	.016
Pot	1200[2/]	1	1200			

US$ 1 = FCFA 242

1/ Price in May, 1977 in a supermarket in Abidjan.

2/ Price in May, 1977 in a supermarket in Abidjan.

3/ Prorated for one year's use.

4/ Prorated for two year's use.

TABLE 21: Daily Goods Cost of Artificial Feeding.

	Daily cost of artifical infant food 1/		Daily cost of equipment (E) 4/		Daily cost of fuel (F) 5/	Total daily goods cost of artificial feeding			
	Alternative (A) 2/	Alternative (B) 3/	Bottles	Thermos & pot		A + E + F		B + E + F	
	FCFA	FCFA	FCFA	FCFA	FCFA	FCFA	US$	FCFA	US$
0-4	124.7	124.7	13.7	3.9	27.6	169.9	0.702	169.9	0.702
4-12	103.5	63	13.7	3.9	27.6	148.7	0.614	108.2	0.447
12-24	69	42	--	3.9	27.6	100.5	0.415	73.5	0.304
Mean: 0-24						128.1	0.529	101.1	0.418

US$ 1 = FCFA 242

1/ From Table 6.

2/ Breast milk is substituted by low solute infant formula 0-24 months.

3/ Breast milk is substituted by low solute infant formula 0-4 months and by whole dry milk 4-24 months as discussed on page 49.

4/ From Table 7.

5/ One hour's use of charcoal.

given in Table 18. The most expensive type of milk was fluid milk*, followed by low solute infant formula. Full cream powdered milk is among the least expensive.

Table 19 shows that the daily cost of artificial infant food in the Ivory Coast would be US 50.37 and ¢0.26 for Alternatives A and B respectively, if averaged over the two-year period.

The costs per day of equipment for artificial feeding were calculated in Table 20. The daily cost for bottles is ¢0.057 and for a thermos and pot is ¢0.016. The cost for fuel, one hour's worth of charcoal per day, was calculated to be an average of US ¢0.11 for the entire country.

In Table 21, all the components of the goods cost of artificial feeding are added together. The total for Alternative A is an average of US ¢0.53 per day, or ¢386.17 for the entire two-year period. For Alternative B, the respective figures are ¢0.42 and ¢305.14.

c. Time costs of breastfeeding

i. Method

Due to lack of availability of data on time spent in infant feeding in the Ivory Coast, the estimate for the time cost of breastfeeding is based on the figures calculated for Ghana. As discussed on pages 81-82, the calculations for Ghana were not based on representative data, but rather on rough estimates combined with measurements on small rural and urban samples of time spent on various activities associated with infant feeding. Thus for Ghana these calculations were meant only to gain a rough perspective on time costs. They are almost equally applicable to the Ivory Coast. As in Ghana, breastfeeding is practiced in a traditional West African fashion in the rural areas, and has only just begun to be replaced in the urban areas (containing about 30% of the population in each country). There is no reason to assume that time used in any aspect of infant feeding in the Ivory Coast would differ from that in Ghana. Ghanaian data on the value of time, based on actual or predicted wage rates, is also used, again assuming that the two countries are similar.

ii. Results

Using the figures for Ghana calculated on page 82, the estimated time cost for breastfeeding in the Ivory Coast is US ¢0.29 per day and ¢211.05 for the entire two-year period of breastfeeding (FCFA 60.9 and 44320.5 respectively).

d. Time cost of artificial feeding

i. Method

As for the time cost of breastfeeding, the time cost of artificial feeding in the Ivory Coast is based on estimates made for Ghana, as discussed on pages 82-86.

ii. Results

Using the figures for Ghana calculated on page 86, the estimated time cost for artificial feeding in the Ivory Coast is US¢0.82 per day and ¢599.04 for the two-year period (FCFA 198.4 and 144,967.7 respectively).

*Fluid milk was so expensive because it was imported in liquid form from Europe, mainly for the use of expatriates.

e. Disease costs

The various beneficial and harmful effects of breastfeeding and artificial feeding on health have been discussed previously. It has been suggested that the harmful or disease-producing effects of breastfeeding (D_{bf}) and the beneficial effects of artificial feeding (H_{af}) can be considered nil from an economic perspective at the individual level (pages 5-8). For the remaining two terms in the equation, the health-producing effects of breastfeeding (H_{bf}) and the disease-producing effects of artificial feeding (D_{af}), it is not possible to provide even rough quantifications of their value at the individual or family level.

f. Application of data to the model

In summarizing the findings at the individual level, reference is made to equation 12 again. It stated that the incremental value of breastfeeding,

$$BF_i = (H_{bf} + D_{af} + \sum_n G_{af_j} + \sum_p T_{af_k}) - (\sum_m G_{bf_i} + T_{bf})$$

As just noted above, it is not possible to fit in numbers for every term in the equation. However, the terms for which estimates are available can be combined as follows to give a rough approximation of a portion of the incremental value of breastfeeding:

G_{af_j} = US ¢386/305 (Alternative A/B)

G_{bf_i} = 102/51 (Foutou/Rice)

T_{af_k} = 599

T_{bf} = 211

Thus the equation can be reduced to:

$BF_i = H_{bf} + D_{af}$ + US ¢672/591 (Alternative A/B for foutou), or

$BF_i = H_{bf} + D_{af}$ + US ¢723/642 (Alternative A/B for rice)

Thus, in theory, by breastfeeding rather than artificially feeding an infant for two years, the average family in the Ivory Coast would save between US ¢59 and ¢723 in goods and time costs. The further savings due to the lower goods and time costs of disease and malnutrition for breastfeeding would in many cases be substantial.

2. National Level

a. Establishing national infant feeding patterns

(1) Breastfeeding patterns

i. Method

One method of estimating the cost of breast and artificial feeding at the national level is to extrapolate from the family level. This method is more meaningful when it can be based on actual breast and artificial feeding practices in the country. If trends can be established, estimate of future costs can be made, assuming that these trends continue.

However, it is very difficult satisfactorily to determine trends in infant feeding practices for a country. It would require access to long-term longitudinal studies or to several cross-sectional studies carried out at different points in time on sample populations which were comparable and, ideally, representative of the total population. Unfortunately, samples used from one study to another are usually neither representative nor comparable to each other. If estimates of trends are, nevertheless, to be hazarded, it is useful when possible to analyze data from rural and urban areas separately, as differences between them are often large and urban trends may be different from those in rural areas. Due to lack of data for rural areas, this was not possible for the Ivory Coast.

It is often difficult to compare the findings of different studies because they are reported in different ways. In particular, weaning ages* are often reported in categories which differ from one study to another. This problem may be partly overcome by recalculating and standardizing the reported figures to the extent this is possible. Perhaps the most useful approach is to treat each study as if it were longitudinal. Then cumulative percentages of infants weaned by the ages at the upper limit of each age category can be calculated and plotted. For example, if a study reported that 10% of infants were weaned at 0-3 months of age, 20% at 3-6 months, 40% at 6-9 months, and no infants were being breast fed beyond 12 months, the following cumulative percentages could be plotted, with age as the abscissa and percentage the ordinal axis: 3 months: 10%, 6 months: 30%, 9 months: 70%, and 12 months: 100%. When data are plotted in this way, changes in the total pattern of breastfeeding from one study to another can be detected. For example, if one study reflected a decrease in extended breastfeeding, the upper portion of its cumulative weaning age curve would be shifted to the left. This method also allows the median weaning age to be estimated as the point where the cumulative curve crosses the 50th percentile. This median weaning age is a convenient if rough method of comparing the findings of different studies in a summary fashion.

For all available studies which satisfactorily reported weaning ages, the data were recalculated into cumulative percentages using this method. Five such studies were found, all carried out in Abidjan, within a short span of time.

ii. Results

Cumulative percentages of infants weaned up to two years of age are plotted in Figure 1. The data suggest that the duration of breastfeeding in Abidjan is still rather long. With the exception of the study carried out among women working within the health profession (Delormas, 1972), the median weaning age falls between 15 and 23 months.

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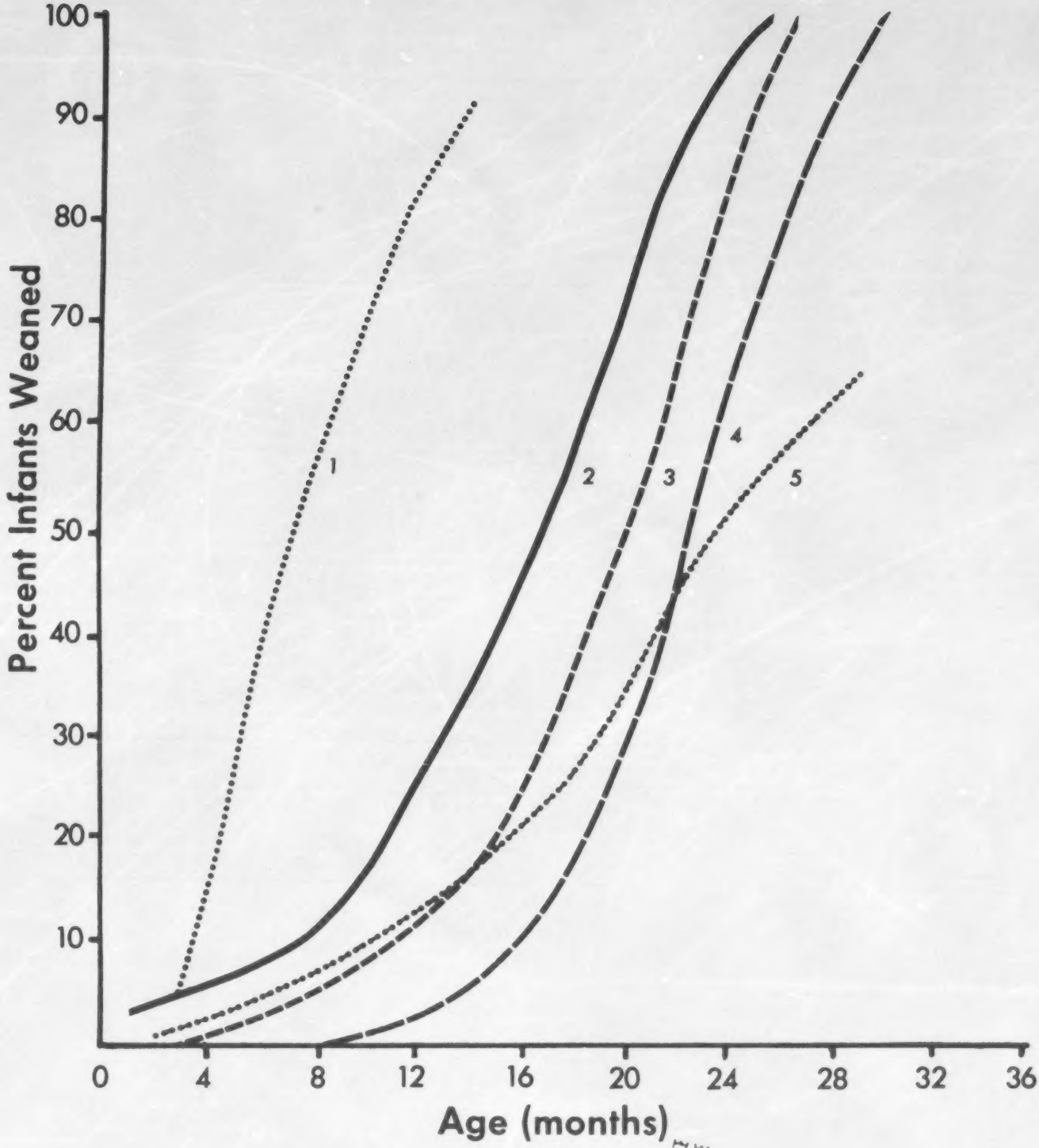
*The age of weaning is defined here as the age at which breastfeeding is completely discontinued (sevrage).

FIGURE 1: Duration of Breastfeeding in Abidjan, Ivory Coast.



Footnotes to Figure 1.

1/ Cross-sectional study, carried out around 1972 among women working within the health profession, N = 180 (Delormas, 1972).

2/ Longitudinal study carried out in 1972, N = 237 (Sieye, 1975).

3/ Cross-sectional study carried out in 1974 at clinics for mothers and infants, N = 343 (Dutertre and Paul, 1975).

4/ Cross-sectional study carried out in 1973-4, N = 251 (Haddad, 1975).

5/ Cross-sectional study carried out in 1972 at clinics for mothers and infants, N = 232 (Delormas, et al., 1974).

(2) Artificial feeding patterns

i. Method

It would be useful to have data on the age on introduction of various artificial feeds, because a rise in artificial feeding may precede a decline in the duration of breastfeeding. Artificial infant foods may substitute for breast milk even when intended as a supplement. In some cases supplementary bottle feeding may precipitate a viscious cycle of declining breast milk production which leads to lactation failure. Unfortunately, research on the age of introduction of artificial feeds seldom discriminates between the time when an infant is first given a taste of a food and the time when it becomes a stable part of the infant's diet in significant quantities.

Some conclusions on the extent of artificial feeding at the national level can be inferred from data on the sales and/or import of these products. The total sales of infant formula usually can be obtained from the various companies operating in a country, as long as assurances are given that they will not be reported separately (revealing market share data to competitors). In rare cases infant formulas are reported in separate import categories, but usually they are combined with powdered milk or with other infant foods. With respect to other types of milk used to substitute for breast milk, market research on usage patterns is seldom available, and thus it is difficult to estimate the extent to which each product is used for infant feeding, let alone the extent to which it actually substitutes for breast milk. Local fresh milk production is especially difficult to measure, yet in some areas it may be the main breast milk substitute.

There are a number of sources for import data. In general, import statistics from the country itself are the most accurate and detailed. However, since these may be incomplete at times and errors are possible irrespective of data source, it is wise to consult other sources simultaneously.

Donations of milk by various aid agencies may or may not be included in the import figures. In some countries this may at time represent a substantial proportion of the available milk. Donor agencies are the best source of information on quantities donated and the method by which this milk is distributed. If it is distributed through health clinics, efforts should be made to determine the extent to which it is used for infant feeding.

ii. Results

For the Ivory Coast, the only available data relevant to the national pattern of artificial feeding comes from milk imports. Table 22 gives the amounts and the value of imports of various kinds of milk into the Ivory Coast from 1961 to 1976, based on FAO statistics. Since production of milk is negligible, the supply of milk in the country is practically equal to the amount imported.

The number of calories consumed per person per day for the different kinds of milk is plotted in Figure 2. It shows that per capita milk consumption in the Ivory Coast is low. The increase in evaporated and condensed milk is probably not associated with an increase in artificial feed-

TABLE 22: Imports of Milk and Cream into the Ivory Coast, 1961-1976.

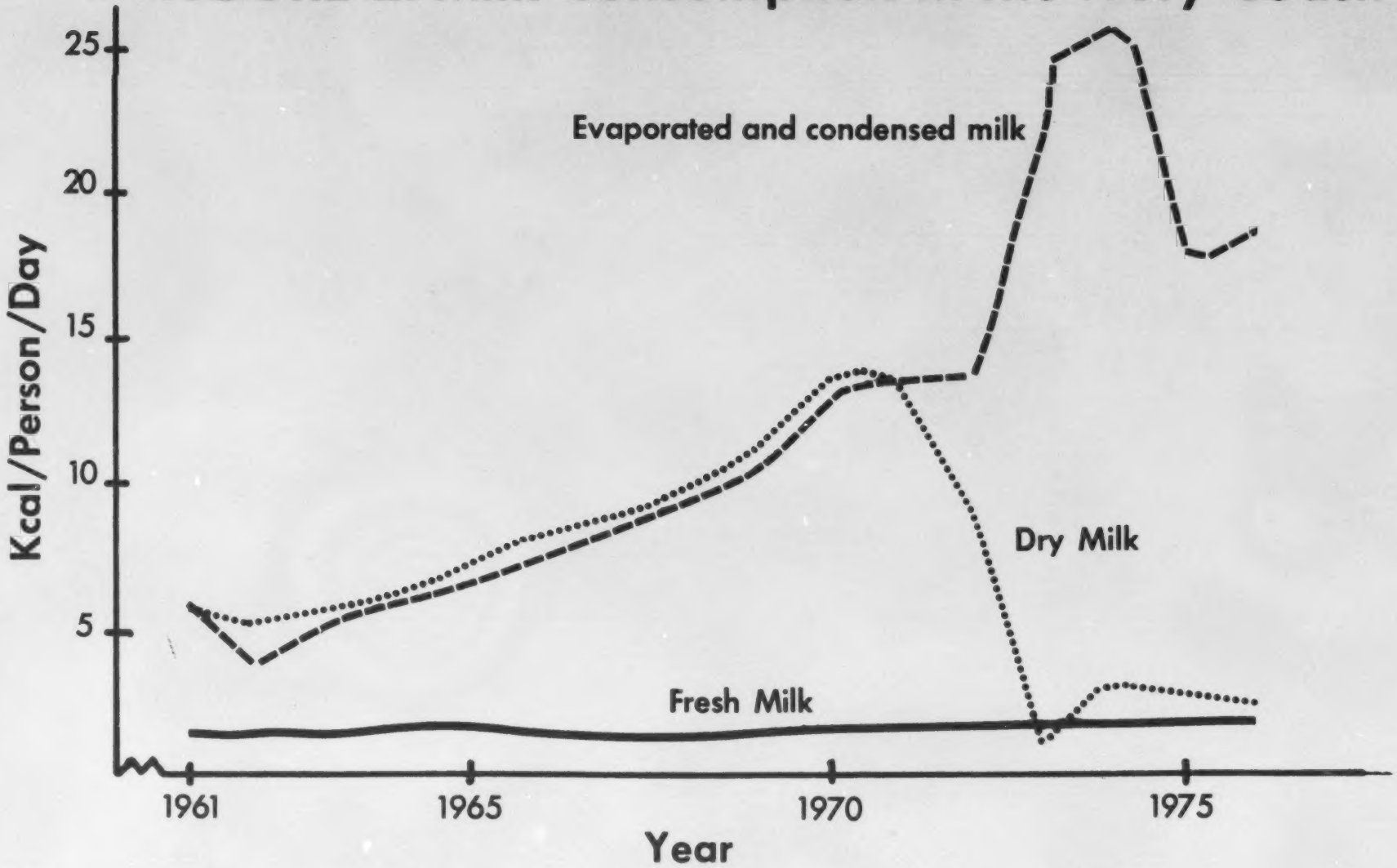
Year	Fresh		Evaporated and Condensed		Dry	
	metric tons	US $ 1000	metric tons	US $ 1000	metric tons	US $ 1000
1961	978	234	3429 1/	1246 1/	2186	984
1962	877	219	2200 1/	764 1/	1859	828
1963	950	235	3140 1/	1030 1/	2200	930
1964	1083	249	3549 1/	1334 1/	2472	1270
1965	1051	280	4130 1/	1507 1/	2976	1553
1966	904	285	8063	3060	3347	1652
1967	878	293	9127	3840	3633	1837
1968	870	301	10418	4322	4178	2058
1969	911	322	11937	4851	4865	2219
1970	998	330	15562	6894	6337	3148
1971	984	354	15682	8080	5981	3813
1972	889	282	14609	7850	4822	3050
1973	982	458	18767	11027	590	943
1974	1349	657	20064	13464	1704	2815
1975	1248	836	13881	12568	1297	2140
1976	1200 2/	850 2/	24000 2/	20000 2/	1300 2/	2400 2/

Sources: Integrated St. System Turn Around Document for the Ivory Coast, November, 1976 except for "Milk and cream, evaporated, condensed", 1966-1967 which is a revised version (Pariboni, 1977). Unpublished data made available by FAO.

1/ This probably includes only evaporated milk and not condensed milk, and thus is an underestimate.

2/ Estimate.

FIGURE 2: Milk Consumption in the Ivory Coast.



Source: FAO, Food supply analysis (first output), Ivory Coast, November, 1976.
Unpublished data made available by FAO.

ing, since these milks are not very commonly given to infants and young children in the Ivory Coast (Delormas, et al, 1974:27).

The consumption of dry milk rose steadily until around 1970, but has been declining since then. The proportion of all powdered milk which is consumed by infants is probably small. Thus it is unlikely that a minor increase in artificial feeding would be reflected in import statistics. In a country such as the Ivory Coast, this might be masked, for example, by a change in the number of expatriates. However, import figures from the Ministry of Economics and Finance (1973, 1974, and 1975) indicate that the import of "dry sweetened milk" (probably infant milk used virtually exclusively for infants) more than doubled from 1973 to 1974. Unfortunately, in 1975 the import categories for milk changed, making it impossible to see if the imports of "dry sweetened milk" continued to rise.

At present no milk is distributed in the Ivory Coast through the World Food Programme (Lambrinides, 1977). UNICEF has apparently not been donating any milk to the Ivory Coast for about ten years (Welffens, 1977). There did not appear to be any other agency distributing sizeable quantities of milk, so the data in Table 22 are probably relatively complete.

b. Economic impact of hypothetical changes in infant feeding patterns

i. Method

As noted above, the data on breast and artificial feeding patterns in the Ivory Coast do not cover the entire country, nor can they be used to establish trends. Therefore, it was only possible to estimate roughly the economic impact of hypothetical changes in infant feeding patterns at the national level.

Two calculations were made, the first based on the hypothetical situation in which all infants in the Ivory Coast were breast fed until the age of two years. The second calculation attempted to estimate the economic impact if a developing country like the Ivory Coast were to experience a reduction in breastfeeding to levels prevailing in developed countries.

Sieye's (1975) longitudinal study (No. 2 in Figure 1), carried out in Abidjan in 1972 was used as if it were representative of the current breastfeeding pattern in the entire country. Presumably this underestimates the actual duration of breastfeeding, since weaning typically occurs much later in rural areas. It was thought that Paris, in which a longitudinal breastfeeding study was done in 1955 (Hindley, et al., 1965), might serve as a model for future changes that could take place in the Ivory Coast.

Data from these two studies were graphed. Instead of plots of weaning ages, as described on page 57, the percentage of infants still being breast fed at each age was plotted. These data were then tabulated. For the first hypothetical case, the percentage of infants at each age not being breast fed in Abidjan was calculated. For the second hypothetical case, the difference between Abidjan and Paris in percentage of infants being breast fed at each age was calculated. To simplify calculations, the means for the age intervals 0-4 months, 4-12 months, and 12-24 months were calculated.

The goods cost component of breastfeeding and artificial feeding was the only one based on reliable enough data to be used in estimating the economic effects of these hypothetical changes in infant feeding patterns. The annual additional cost to the entire country of artificial feeding over breastfeeding was estimated by multiplying the daily additional costs per mother-infant couple times the number of infants, times the number of days in each age interval.

Given an estimated population of 6.7 million (Overseas Business Reports, 1976a) and a birth rate of 46 per 1000 (WHO, 1976), the number of infants for the first year would be 308,200. Subtracting out the estimated infant mortality rate of 138 per 1000 (WHO, 1976), the number of infants for the second year would decrease to 265,668.

ii. Results

The graphs in Figure 3 depict the duration of breastfeeding in Abidjan and Paris. Rates of breastfeeding in the two cities are listed in Table 23. For use in later calculations, the table includes percentages of children in Abidjan not being breast fed at each age and the difference between Paris and Abidjan in percentage of children being breast fed at each age.

Table 24 shows that the daily additional goods cost of artificial feeding over breastfeeding is US$0.39 for Alternative A and $0.28 for Alternative B when the mother's supplement is foutou and peanut sauce. If the lactation supplement is rice and peanut sauce, the corresponding figures are $0.46 and 0.35.

Table 25 displays one of the calculations for the annual goods cost savings which would result if every infant in the Ivory Coast were breast fed for two years. This is for the case in which the mother's supplement is foutou with peanut sauce and the artificial infant food is low solute infant formula for the entire two years (Alternative A). The savings then amounts to $23.8 million, and for Alternative B the result is $15.6 million. If the lactation supplement is rice and peanut sauce, the savings is $27.7 million and $19.5 million for Alternatives A and B respectively.

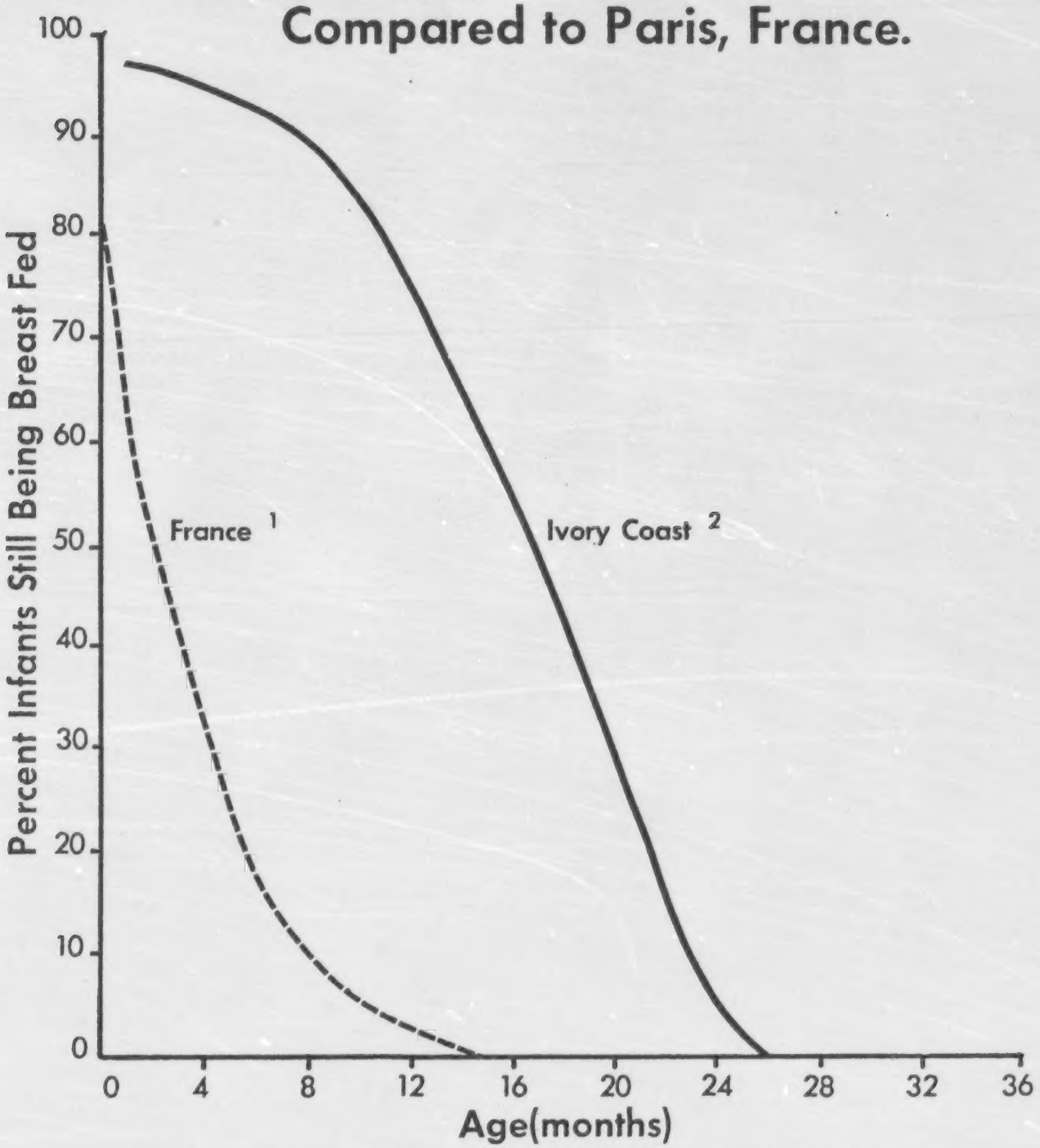
Table 26 shows one of the calculations for the additional goods cost that would result from a hypothetical decline in breastfeeding in the Ivory Coast. As in Table 25, the case shown is the foutou and peanut sauce supplement and Alternative A. The additional goods cost in this case is $46.7 million and for Alternative B it is $33.1 million. For rice and peanut sauce the costs are $ 54.6 million and $41.0 million for Alternatives A and B respectively.

c. Cost of malnutrition resulting from artificial feeding

Occasionally, young exclusively breast-fed infants "fail to thrive." This appears to be a rare phenomenon in the Third World, and no reference to the problem was found for the Ivory Coast or Ghana. More commonly, "starvation at the breast" occurs among older infants. However, this form of malnutrition cannot be said to be due to breastfeeding. It is rather due to a failure properly to supplement the diet of the older breast-fed infant. Artificially-fed infants must also receive adequate supplementary foods at appropriate ages. Therefore, this section focuses neither on the cost of "improper" breastfeeding nor on the cost of improper supplementation, but only on the cost of improper artificial feeding (i.e., breast milk substitution).

In estimating goods costs and time costs, it was necessary to assume that artificial feeding was properly carried out. In fact, artificial feeding is not and probably cannot be carried out satisfactorily under conditions of poverty. It would be valuable to document the costs in terms of human disease and death and in economic terms that result from this fact. However, for the most part, neither available methodology nor data lend themselves to such exercises.

FIGURE 3: Duration of Breastfeeding in Abidjan, Ivory Coast Compared to Paris, France.



1 Study carried out around 1955. (Adapted from graph in Hindley et al., 1965.)

2 Study carried out around 1972 (Sieye, 1975).

TABLE 23: Rates of Breastfeeding in Abidjan, Ivory Coast and Paris, France.

Age months	Abidjan[1] % infants being breast fed	Abidjan[1] % infants not being breast fed		Paris[2] % infants being breast fed	Difference between Abidjan and Paris in percent of infants being breast fed	
1	97	3		64	33	
2	96	4	Mean: 5	53	43	Mean: 48
3	95	5		42	53	
4	94	6		33	61	
5	93	7		24	69	
6	92	8		18	74	
7	91	9		14	77	
8	90	10	Mean: 13	10	80	Mean: 76
9	87	13		7	80	
10	86	14		5	81	
11	80	20		4	76	
12	75	25		3	72	
13	70	30		2	68	
14	66	34		1	65	
15	61	39		0	61	
16	55	45		0	55	
17	50	50		0	50	
18	43	57	Mean: 61	0	43	Mean: 38
19	37	63		0	37	
20	29	71		0	29	
21	22	78		0	22	
22	15	85		0	15	
23	11	89		0	11	
24	6	94		0	6	

1/ Estimates based on a study carried out in about 1972, N = 237 (Sieye, 1975).

2/ Estimates based on a study carried out in about 1955, N = 588 (Hindley, et al., 1965).

TABLE 24: Daily Additional Goods Cost of Artificial Feeding Over Breastfeeding in the Ivory Coast

Age of infant (months)	Total daily goods cost of artificial feeding 1/		Total daily goods cost of breast-feeding 2/		Daily additional goods cost of artificial feeding over breastfeeding							
	Alternative A	Alternative B	Foutou + Sauce	Rice + Sauce	A - Foutou		A - Rice		B - Foutou		B - Rice	
	FCFA	FCFA	FCFA	FCFA	FCFA	US$	FCFA	US$	FCFA	US$	FCFA	US$
0-4	169.9	169.9	45.8	23.5	124.1	0.513	146.4	0.065	124.1	0.513	146.4	0.605
4-12	148.7	108.2	38.0	19.5	110.7	0.457	129.2	0.534	70.2	0.290	88.7	0.367
12-24	100.5	73.5	25.3	13.0	75.2	0.311	87.5	0.362	48.2	0.199	60.5	0.250
mean: 0-24	128.1	101.1	32.9	16.9	95.2	0.393	111.2	0.460	68.2	0.282	84.2	0.348

US$ 1 = FCFA 242.

1/ From Table 8.

2/ From Table 4.

TABLE 25: The Goods Cost Savings if all Infants in the Ivory Coast Were Breast fed for Two Years.

Age of infant (months)	Proportion of infants not breast fed 1/ (P)	Number of infants 2/ (I)	Number of days (D)	Daily additional goods cost of artificial feeding over breast-feeding 3/ (C) FCFA	Total additional goods cost of artificial feeding over breast-feeding (P x I x D x C) mill. FCFA	mill. US$
0-4	.05	308,200	122	124.1	233.3	1.0
4-12	.13	308,200	243	110.7	1077.8	4.5
12-24	.61	265,668	365	75.2	4448.2	18.4
Total: 0-24					5759.3	23.8

US$ 1 = FCFA 242

1/ Mean percent of infants in each age interval not being breast fed in Abidjan in 1972, from Table 23.

2/ Based on an estimated population of 6.7 million for 1976 (Overseas Business Reports 1976a) and a birth rate of 46 per 1000 (WHO, 1976) for the first year. Recalculated for the second year given an infant mortality rate of 138 per 1000 (WHO, 1976).

3/ From Table 24 (A - Foutou), i.e. mother's extra food is foutou with peanut sauce and breast milk is substituted by low solute infant formula.

TABLE 26: The Additional Goods Cost of a Hypothetical Decline in Breastfeeding in the Ivory Coast.

Age of infant (months)	Proportion of infants not breast fed 1/ (P)	Number of infants 2/ (I)	Number of days (D)	Daily additional goods cost of artificial feeding over breast-feeding 3/ (C) FCFA	Total additional goods cost of artificial feeding over breast-feeding (P x I x D x C) mill. FCFA	mill. US$
0-4	.48	308,200	122	124.1	2239.8	9.3
4-12	.76	308,200	243	110.7	6300.9	26.0
12-24	.38	265,668	365	75.2	2771.0	11.5
Total: 0-24					11,311.7	46.7

US$ 1 = FCFA 242

1/ Mean percent of infants in each age interval who would not be breast fed if the pattern of breast-feeding in Abidjan (1972) would become identical to that in Paris (1955). From Table 23.

2/ Based on an estimated population of 6.7 million for 1976 (Overseas Business Reports 1976a) and a birth rate of 46 per 1000 (WHO, 1976) for the first year. Recalculated for the second year given an infant mortality rate of 138 per 1000 (WHO 1976).

3/ From Table 24 (A - Foutou), i.e. mother's extra food is foutou and peanut sauce and breast milk is substituted by low solute infant formula.

(1) Extent of protein-calorie malnutrition

The Ministry of Health in the Ivory Coast has been publishing health statistics for over a decade. The other major sources of information on childhood malnutrition and disease are reports on studies of hospital admissions and scattered reports of small-scale field studies.

Table 27 shows the percentage of children, 0-14 years of age, diagnosed as suffering from malnutrition and from diarrhea or measles (which are often closely associated with malnutrition) in 1975. Even if all children with a diagnosis of avitaminosis, kwashiorkor or other metabolic or nutritional diseases are assumed to be suffering from malnutrition, this amounts to only 2% of all diagnoses for the entire age range and 2.5% for children 1-4 years old. Similarly the figures of 3% for diarrhea and 5% for measles for age 0-14 are low.

A number of studies analyzing the reasons for admission to pediatric wards summarized in Table 28, show a different picture. These figures are much higher, especially for malnutrition. Yet data based on diagnoses still underestimate the prevalence of malnutrition among children admitted to hospitals or visiting clinics. Ledecq (1974) found that, in addition to the 16% of children diagnosed as malnourished, another 18% of the children in Bouake hospital were below 70% of the standard weight for age. A similar study, undertaken by one of the authors (SA) in the same hospital in 1977 showed that the percentage of children diagnosed as malnourished had remained the same, but the non-diagnosed cases had risen to 28% using the same criterion (or 38% using 75% weight for age, the Gomez cut-off point for second degree malnutrition) over half (16+38=54%) of the children visiting the pediatric ward were either severely or moderately malnourished. Further details on these studies are presented in Appendix II. Table 29 shows the importance of malnutrition, diarrhea and measles as causes of death among children admitted to hospitals in the Ivory Coast.

Data on the prevalence of malnutrition in the Ivory Coast are sparse. Ravelli (1972) found that 31% of a sample of 72 children under five years of age in a rural village suffered from mild to moderate malnutrition (defined as 60-80% of standard weight for age). Four out of 11 children in three other villages were reported as falling into this same range (Burnier, 1972). From measurements of weight and midarm circumference, Gabbud et al. (1975) concluded that one-third of a sample of 297 children under five years old in an isolated rural area had moderate malnutrition, but they did not find a single case of severe malnutrition.

Despite this lack of data on malnutrition in general, there is mounting evidence that artificial infant feeding is contributing substantially to disease and malnutrition, at least in urban areas. In a report on hospital admissions for gastroenteritis in Abidjan, Adou (1977a) notes that "artificial feeding played an important role even in the babies aged less than 6 months..." An examination of the causes of death at a pediatric ward showed that among children less than one year old, marasmus was the main cause of death, with diarrhea ranking fourth. Over one-third of the children who died from diarrhea, and nearly all who died from marasmus had been artificially fed (Adou, 1976). Of children admitted for malnutrition, the percentage who had been artificially fed increased from 14% in 1975 to 22% in 1976.*

(2) Cost of malnutrition

Available data were inadequate to estimate any aspect of the cost of malnutrition in the Ivory Coast. However, for Ghana, estimated costs of re-

*Calculated from data provided by Adou, 1977b.

TABLE 27: Diagnoses of Children 0-14 years, in Hospitals or Visiting Clinics in the Ivory Coast in 1975.

Age (years)	Avitaminosis (1)	Kwashiorkor (2)	Other metab. and nutr. dis. (3)	Malnutrition (1) + (2) + (3)	Severe Diarrhea	Measles
0-1	.9	.3	1.0	2.2	4.0	6.0
1-4	.9	.5	1.0	2.4	3.5	7.0
5-14	.7	.1	.7	1.5	2.7	3.0
0-14	.8	.3	.8	1.9	3.2	5.1

Source: Ministere d'Etat Charge de la Sante Publique et de la population. Service Autonome des Statistiques Sanitaires et de la Consumentation. Annuaire Statistique. Resultat de 1975, Abidjan, 1976.

TABLE 28: Reasons for Admission to Pediatric Ward at Hospitals in the Ivory Coast, 1962-1977.

Author	Year of Study	Hospital	Per cent of admissions		
			Malnutrition	Diarrhea	Measles
Banaivu	1962-64	Central, Abidjan	19		
Kassi 1971	1968	Treichville, Abidjan	20	16.7	9.1
De Paillerets	1968-69	Treichville, Central Abidjan	18		
Kassi 1971	1969	Treichville, Abidjan	19	16	7.9
Adou 1970	1969	Cocody, Abidjan	9		
Adou 1970	1970	Cocody, Abidjan	10.2		
Haddad	1973	Port Boet, Abidjan	25.4		
Haddad	1974	Port Boet, Abidjan	37.2		
Ledecq 1974	1974	Bouake	16		
Adou 1977	1974	Cocody, Abidjan		12.4	
Adou 1976	1975	Treichville	11.8		
Adou 1976	1975	Cocody, Abidjan	2.9		
Almroth	1976-77	Bouake	14	15.3	17.6
Mean for all studies			18	15	12

TABLE 29: Cause of Death Among Children Admitted to Hospitals in the Ivory Coast.

Author	Year of Study	Hospital	Per cent of deaths		
			Malnutrition	Diarrhea	Measles
Kassi 1971	1968	Treichville, Abidjan	31	9	12.4
Kassi 1971	1969	Treichville, Abidjan	30	13.4	10.8
Adou 1970	1969	Cocody, Abidjan	22		
Adou 1970	1970	Cocody, Abidjan	27.9		
Ledecq 1974	1974	Bouake	25		
Adou 1976	1975	Cocody, Abidjan	7.1		
Adou 1976	1975	Treichville, Abidjan	18		
Mean for all studies			23	11	12

habilitating children who were malnourished due to artificial feeding were calculated (Table 45). Proportional costs can be estimated for the Ivory Coast by assuming that costs of in-patient and out-patient hospital care are the same in the two countries, and that the incidence of malnutrition in the Ivory Coast in 1976 was about 26,000 cases (2 per cent of an estimated 130,000 population of children under five years old). Then the estimated cost for rehabilitating children malnourished due to artificial feeding in 1976 would range as high as US$6.8 million (FCFA 1.6 billion), assuming rehabilitation required 30 days of in-patient care per child and that 25% of malnutrition were due to artificial feeding. The cost would range as low as US$45,000 (FCFA 11 million) if assumptions were changed to 10 days of out-patient care and 10% of malnutrition due to artificial feeding.

These are very rough estimates based on a number of uncertain assumptions. But two other crucial points must be kept in mind in interpreting these data: (1) rehabilitation represents only a portion of the costs of malnutrition to society (and does not include most of the cost to the victim and his/her family), and (2) these relatively low costs directly reflect the assumption that artificial feeding is practiced at a relatively low level in the Ivory Coast.

d. Birth spacing effect of breast feeding

In the Ivory Coast, the rate of population growth is regarded as acceptable, and there is no national family planning program (Population Reference Bureau, 1976:40-41). However, many Ivorian health professionals consider adequate birth spacing to be an important factor in ensuring infant health and survival. In circumstances where modern contraceptives are not used, lactation amenorrhea plays a crucial role in birth spacing.

B. Ghana (See Appendix IV)

1. The Economic Situation in Ghana and its Implications for the Present Study

Ghana, like many developing countries, has experienced many periods of economic instability and crisis in the last two decades. Three of the major factors responsible for this have been (1) fluctuations in the world prices of cocoa, since this has long accounted for the major share of Ghana's foreign exchange earnings (around 60% in recent years) (Overseas Business Reports, 1976b); (2) a widely fluctuating but increasingly high rate of inflation; (3) external trade deficits, in part due to the two factors above, that is, low world prices for cocoa and other agricultural products, and high world inflation rates, but at times in the past also due in part to inappropriate import policies (Central Bureau of Statistics, 1976).

Ghana's economic situation became particularly critical in the early 1970's. The civilian government that had taken office in late 1969, greatly liberalized import restrictions which had been introduced in 1961. This led to such accelerated imports during 1969-1970, when cocoa prices were high, that the country's foreign exchange position became critical in 1971 when the export price for cocoa dropped from ¢830 to ¢631 per long ton. This in turn led to a 44% devaluation in the cedi against the dollar. A coup followed in 1972, and the new military regime revalued the cedi to a net devaluation of only 20%.

However, the combination of low cocoa prices and accelerated imports during 1971 led to a balance of payments deficit on current account that year of an unprecedented ¢146.4 million (Central Bureau of Statistics, 1976). The new government repudiated debts of £ 13 million owed to four British companies, abrogated £ 33 million of moratorium interest due to be paid between 1972 and 1982, and announced rescheduling of medium term debts*. This resulted in the loss of all import credits, obliging the government to embark on a policy of import restriction. Total imports for 1972 were only 62% of those for 1971 (Rimmer, 1976:367). Foreign exchange has remained a problem, and imports have been strictly limited ever since.

Ghana experienced several periods of high inflation in its past, particularly toward the end of the regime of President Nkrumah in 1965, when it approached 30 per cent per year. Beginning in 1973, it began to suffer in particular from "imported inflation", which accelerated when crude oil prices quadrupled at the end of that year (Lisk, 1976). Government efforts to stem inflation were only temporarily successful, and by mid-1974, consumer price increases in Ghana began to outstrip those for the world and for the rest of Africa (International Monetary Fund, 1976:162). They have continued to accelerate, and the consumer price index for December, 1976, of 783.3 (March 1963=100), represented a 67% increase over that for December, 1975 (calculated from Central Bureau of Statistics, 1977).

The official foreign exchange rate of the new cedi when it was established in 1972 has been held constant ever since, despite great pressures against it. Although the official rate is US $1.00 = N¢1.15, the Zürich bank rate was $1.00 = N¢3.00 in the first half of 1976. By December, 1976, this had fallen to $1.00 = N¢9.75 (Ministry of Health Planning Unit, 1977). The results of this situation are serious and pervasive throughout the economy. Among them are an active black market in foreign currency and a strong incentive for smuggling goods out of the country to obtain it. According to the Head of State Archeampong, hoarding and profiteering may have been part of the cause of the high rate of inflation, but smuggling has perhaps been even more important, with huge volumes of commodities finding their way into Togo (West Africa, 1976b), and domestically grown food, especially rice, being smuggled into Upper Volta (West Africa, 1976a).

These economic problems have a number of implications for the present study. Some of the calculations involved in estimating the incremental economic value of breastfeeding require that prices and/or wages gathered at different periods in time be made comparable. This can often be accomplished by standardizing all values to a particular point in time using a consumer price index and assuming that wages vary in a manner similar to prices. In Ghana, this introduces some error, because wages tend to lag behind prices, especially for unskilled workers (Lisk, 1976).

At the time prices were gathered for this study (May-June, 1977), Ghana was experiencing severe price-related problems wihich would throw strong doubt on the validity of any comparisons of the costs of breast and artificial feeding which was based on those prices. To calculate the cost off additional foods needed to produce breast milk, prices of local foods would be needed. But local food prices had skyrocketed, due not only to accelerating inflation, but also to a number of food marketing and agricultural problems. In addition, this was the peak of the annual "hungry season" in a year with impending poor harvests due to drought. Harvests had been poor in three of the four pre-

*A settlement on these matters was reached in mid-1974. (Rimmer, 1976).

vious years in much of the country. On the other hand, prices for many imported foods, including baby foods and milk products, were officially held at controlled levels, thus while the consumer price index for local food was 1027.3 in December, 1976 (and would have been much higher six months later when prices were collected), it was only 393.1 for imported foods (and probably the same six months later). Thus, for example, if calculations based on 1963 prices showed the goods cost of artificial feeding to be twice as high as that for breastfeeding, and if the prices for the identical goods varied with their respective indices, then by December, 1976, the cost of artificial feeding would appear to be less than that for breastfeeding.

Of course, this does not reflect the true situation a Ghanaian mother was faced with, since infant formula was available at control prices for few if any mothers. Imports of infant formula during 1975 and 1976 amounted to only about 10% of the estimated demand, according to needs projected for 1977 by the government procurement agency. Of those imports, an unknown proportion was sold at black market prices of N¢10-20 (the control price was less than N¢2 for a one-pound tin (Prices and Incomes Board, 1976: 32)).

2. Analyses at the Individual Level

a. Goods cost of Breastfeeding

i. Method

Very little research has been done on diets of lactating mothers in Ghana. Davey (1961b) obtained food consumption records for over 100 women, among whom undoubtedly many were lactating; however, they were not considered separately. Records for eight pregnant women suggested that they had about the same nutrient intake as the others: about 2000 calories and 60 grams of protein per day.

However, Davey (1963) did comment that, during the early stages of lactation, women in Ghana ate extra food rich in fat and protein. In contrast to a widespread failure to appreciate the increased nutritional needs of pregnant women, he found that awareness of lactating women's extra needs was universal.

Sai (1958) wrote that in many areas of Ghana gifts of food and clothing were brought to women at an "outdooring" ceremony one week after delivery, and that this helped ensure adequate nutrition for the mother for about three months.

Few food taboos appear to exist for lactating women, and these generally do not include foods which play an important role in the average diet (Peckan and Ngui, 1967:76; den Hartog, 1970:29). Table 30 lists daily calorie and protein intakes for a number of lactating women, as recorded in various dietary studies in Ghana. For the eight studies on a total of 24 lactating women in various parts of the country, the mean calorie intake was 1836 (range 1488 - 2600), and the mean protein intake was 37.2 g (range 27.3 - 76.0).

However, many of these studies may have made the mistake of underestimating the entire 24-hour food intake, which is especially likely

TABLE 30: Daily Calorie and Protein Intakes of Lactating Women in Ghana.

Reference	Sample size	Body weight	Calories (KCAL)	Protein (gm)	Ethnic background
Grant, 1955a	2	--	2600	31	Ewe
Grant, 1955a	2	--	1700	38	Akwapim
Dako & Watson, 1972	3	48	1730	33.9	Brong
Dako & Watson, 1972	5		2093	38.1	Dagarti
Orraca-Tettah, 1972	3	61	1856*	53.3	Ga
Orraca-Tettah, 1973	1	57.7	1664	35.3	Ga
Gommey & Anang, 1975	7	--	1488	27.3	Ga
Orraca-Tettah, 1975	1	--	2226	76.0	Ga
Mean for all studies	24		1836	37.2	

*Calculated from data showing that the diet contained 354 g carbohydrates and 20 g fat in addition to 53.3 g protein (using 4.1 kcal/g protein and carbohydrate and 9.3 kcal/g fat (Abramson, 1971)).

to occur for women who process foods and prepare meals, or for market women who daily spend many hours around food. In any case, as discussed on page 19, our analyses will assume that breast milk production is fully subsidized by increased food intake.

Ghana's economic anomalies and distortions, as discussed above, make it virtually impossible to establish reliable prices which fairly represent the relative goods cost of breastfeeding versus artificial feeding. It was felt that a much more accurate picture of the situation likely to be found in Ghana over the long run would be obtained by utilizing the calculations made for the Ivory Coast.

The food supplements used in the Ivory Coast calculations, foutou or rice with peanut sauce, are equally appropriate for Ghana. Foufou, the Ghanaian equivalent to foutou, is widely eaten with soups and stews (in fact, mothers often believe that such foods, especially palm nut soup, stimulate breast milk production (Nutrition Unit, 1968:25-26; Steckle, 1975:140)). In Ghana, also, rice cultivation and consumption are rapidly increasing.

The calculations made for the Ivory Coast are simply modified for use for Ghana. The currency conversion factor was N¢ 1.00 = FCFA 210. It was possible to estimate roughly urban and rural differences based on urban versus rural consumer price indices. Food costs were taken from Table 17.

ii. Results

The estimated daily goods cost of breastfeeding in Ghana at the individual level is presented in Table 31. Based on a food supplement of foutou with peanut sauce, the average for the entire country is US$ 0.14 per day or a total of $102.20 for two years per infant, or $0.07 and $51.10 respectively based on rice in place of foutou.

b. Goods cost of artificial feeding

i. Method

Costs of artificial infant food, equipment and fuel* are also based on data from the Ivory Coast (Tables 19-21). Rural and urban prices are considered to be the same for food and equipment, though, in fact these commodities were virtually unavailable in rural areas at the time of the study (and probably would be more expensive if they were). Since rural people gather, rather than purchase more of their fuel than urban people, the goods cost of fuel in rural areas is reduced arbitrarily to 25% of the urban cost.

ii. Results

The estimated daily goods cost of artificial feeding in Ghana at the individual level is presented in Table 32. The average for the entire country for Alternative A and B is US$0.53 and 0.42 respectively per day or $386.90 and 305.36 respectively for an entire two years of artificial feeding, per infant.

*Charcoal is as appropriate for Ghana as for the Ivory Coast. It is commonly used as a fuel for cooking (Steckle, 1972:84; Dako and Watson, 1974:13), and may be preferred over firewood when readily available (Steckle, 1975:105-6).

TABLE 31: Daily Goods Cost of Breastfeeding an Infant in Ghana

	Food supplement for mother			
	Foutou and peanut sauce		Rice and peanut sauce	
	N¢	US$	N¢	US$
Entire country	0.160	0.140	.080	.070
Urban	0.168	0.146	.084	.073
Rural	0.158	0.138	.079	.069

N¢ 1.00 = FCFA 210

Based on data calculated for the Ivory Coast (Table 17). The costs are prorated over two years.

TABLE 32: Daily Goods Cost of Artificial Feeding of an Infant in Ghana

	Artificial infant food		Euipment	Fuel	Total Cost			
	Alternative A	Alternative B			Alternative A		Alternative B	
	N¢	N¢	N¢	N¢	N¢	US$	N¢	US$
Entire country						.53		.42
Urban	.427	.299	.0506	.277	.755	.627	.656	.545
Rural	.427	.299	.0506	.069	.546	.419	.475	.364

N¢ 1.00 = FCFA 210

Based on data calculated for the Ivory Coast (Tables 19, 20, and 21)

Costs are prorated over two years.

c. Time cost of breastfeeding

i. Method

Very little data on time spent in infant feeding in Ghana was found in a review of the literature. Therefore, a small infant feeding time study was commissioned by the authors during June, 1977. It was meant to obtain rough estimates, not representative data, so small, non-random samples were chosen. Six mother-infant pairs in the northern village of Langbensi, Ghana, and 15 in the capital, Accra, were observed for several hours each, and a short questionnaire was administered to the mothers. Two mothers in Accra and three in Langbensi were breastfeeding exclusively. Five in Accra and three in Langbensi were breastfeeding with supplemental solid foods. Seven in Accra were bottle feeding, with or without breastfeeding, and one was giving only solid foods.

In addition to time spent on breastfeeding, a lactating mother must spend time to obtain, prepare, and eat additional food. No study was found of food preparation times in Ghana, so the following data were used. It was assumed that a mother spends an equal proportion of her food preparation time on each family member, including herself, and that during lactation the time required to prepare her own food increases by 25%, approximately equivalent to the recommended increase in her calorie consumption. Data from the Ivory Coast (Crapuchet, 1956; Burnier, 1972) suggests that women in isolated rural villages spend 3 hours a day in food preparation and those closer to urban areas spend about 2 hours a day. One study in Ghana (cited by Idusogie, 1972) found 7 consumers per family cooking unit in a rural area and 8 in an urban area. Incremental increases in other aspects of food procurement and consumption were estimated to be 10 minutes per week.

Other potential time costs for breastfeeding include nipple and breast preparation and cleansing (assumed to be small in urban areas and negligible in rural areas), increased water intake (negligible increase in water needed for household use), education needed for breastfeeding (estimated to take longer for urban than for rural mothers, who seldom need or receive instruction beyond their normal ongoing social activities), and time costs incurred in additional health care needed for breastfeeding mothers (nipple problems, etc., lead to small time costs for urban mothers, and even smaller ones for rural mothers).

There are many potential pitfalls in attempting to quantify the value of time. Within a given sample population, the value of time can be estimated according to the wage rate for those who are employed, and "predicted" for those who are not, according to their age, sex, education, skills, etc. This is the type of method used by Popkin (1978) in quantifying the value of time spent in infant feeding in the Philippines.

Where such data are not available, or when "average" figures are required for use in making national level calculations, a less accurate approach must be relied on. For the present study, the method used illustrates one approach which can be taken as well as the errors that result from the typically inadequate data available. This involves using existing data to estimate the percentage of the population engaged in various employment categories and the income of each.

Data on income in Ghana are scanty, outdated, and available for only a small segment of the population. A national household budget survey was carried out in 1961 (Golding, 1962). Another was carried out only in the Eastern Region in 1967 (Dutta-Roy, 1969) using an improved method (for example, the market value of home-produced and consumed foods was included). Excellent data on income structures for one city (Cape Coast) were gathered in 1971 (Hinderink and Sterkenberg, 1975). Data from these studies were used to estimate roughly average incomes in Ghana. The data were standardized to reflect inflation rates by adjusting them to the consumer price index for December, 1976, accounting also for fluctuations

in foreign exchange rates for the Ghanaian cedi (Rimmer, 1976). Accurate data on differences in rural and urban incomes were available only from the more recent household budget survey (Dutta-Roy, 1969). These were applied to the entire country, though in fact, the data were only from the Eastern Region. Rough estimates of differences in income by sex were made, based on calculations from 1960 data (Vyas and Leith, 1974) showing that average male earnings were on the order of 50% higher than average female earnings.

The resulting data would be expected to overestimate actual average incomes in Ghana for several reasons. First, wages probably did not rise nearly as fast as the consumer price index (Lisk, 1976). Second, most of the income data and the rural-urban differences come from southern Ghana, which is wealthier and more urbanized than the north, with much less subsistence farming. Third, predicted incomes are included for a sizeable proportion of the population which in fact earns little or no income. Fourth, many workers recorded in each category do not earn the typical annual income because they work part time, seasonally, or receive part or all of their income in kind.

However, the purpose of assembling the data is to estimate the value of time, not to estimate incomes reliably. In fact, the overestimate is to a large extent justified. If someone in the family does not gather fuel, carry water, tend the garden, mind the livestock, make the meals, or look after the children, these services will have to be purchased or the family nutritional status will suffer and disease costs will rise. Therefore, in the calculations below, these data are used as rough estimates of the value of time in Ghana, in spite of the fact that they overestimate incomes.

ii. Results

The daily time spent on breastfeeding is recorded in Table 33. Rural mothers breast feed more times per day than urban mothers, but spend less time per feed, so the daily total was similar, 47.8 minutes for urban Accra and 40.1 minutes for rural Langbensi. Taking the exclusively breast fed infants separately, the total daily time was 79.0 and 50.3 minutes respectively.

The data from Table 33 are combined with estimates of time used in other activities associated with breastfeeding and reported in Table 34 on a weekly basis over a two year period. The average total daily times for all of Ghana are also given.

Table 35 lists the estimated value of time per hour for various occupation groups by sex. If the wage rate for breastfeeding women is considered to be the average for women, US$0.33/hour for rural and $0.37/hour for urban, then the daily cost of the time spent on breastfeeding (48.6 and 55.1 minutes, respectively) is $0.27 for rural and $0.34 for urban breastfeeding women. Weighting the rural and urban figures according to proportions of the population which they represent (.7 and .3), this amounts to $0.29 per day or $211.05 for two years of breastfeeding per infant.

d. Time cost of artificial feeding

i. Method

Data on time required for artificial feeding were also gathered in the infant feeding time study described on page 81, but there were no artificially fed infants in the rural sample. It is assumed that the time required to actually feed the bottle to the infant is the same in rural and urban settings.

The time actually spent by urban mothers for preparing feeds and washing and sterilizing utensils was 266 minutes per week, but this was not used for the calculations. This is because it was obvious that the practices observed were inadequate to provide safe feeds for the infant. Although it would be desirable to use data representative of actual practices, this would require an estimate of the time lost due to the resulting infant disease and death.

TABLE 33: Infant Feeding Time Study in Ghana, 1977.

Location	N	Age in months	Feeds per day	Minutes per feed	Minutes per day	Minutes prep & wash
Breastfeeding						
Accra	10	4.8 (.5-10)	4.8 (2-8)	10.4 (5-15)	47.8 (18-84)	---
Langbensi	6	7.6 (.8-18)	10.2 (7-16)	3.8 (1-10)	40.1 (20-63)	---
Bottle feeding						
Accra	7	7.8 (3.5-15)	3.3 (1.6)	6.7 (4-20)	26.7 (4-70)	38.0 (25-60)
Solid feeding						
Accra	9	8.3 (4-15)	3.2 (1-6)	9.3 (5-15)	28.2 (10-61)	56.4 (25-142)

Accra: Urban

Langbensi: Rural

Values given are means. Numbers in parentheses are ranges.

TABLE 34: Time Used in Activities Associated with Breastfeeding in Ghana

	Minutes per week spent on obtaining goods inputs								Total time (minutes)	
	Feeding	Washing and preparation	Food	Fuel	Water	Utensils	Education	Additional home health care	per week	per day
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Urban	335	5	35	0	1	0	5	·5	386	55.1
Rural	281	0	54	0	3	0	1	1	340	48.6
Entire country									354	50.8

For columns 6-8, time is prorated over a two-year period.

This would have been impossible to estimate because of a total lack of relevant data (e.g., morbidity and mortality rates of breast fed compared to artificially fed infatns; value of time lost by both infant and parents due to sickness and death). Therefore, calculations are based on estimates of the minimum time required to prepare feeds and wash utensils such that severe or recurrent gastroenteritis and other life-threatening diseases are avoided. This estimate assumed that 1 1/2 hours a day would be required for the urban Ghanaian of average socioeconomic status, but that in rurual area, with fewer facilities, it would take 1 1/2 times as long as in urban areas.

From interviews with health professionals and infant food company personnel, it was determined that a Ghanaian mother in May-June, 1977 would have to wait in line for at least 3 hours to obtain a single one-pound tin of powdered formula (or 3 six-ounce tins of evaporated milk). If fed at the rate of 520 ml per day (the mean breast milk output over the two-year period), a pound tin would last for about 4 days. Assuming that urban and rural mothers would have to walk 10 and 20 minutes respectively to and from a sales outlet, the time required to obtain artificial infant foods would come to 333 and 350 minutes per week, respectively. (Mothers could reduce this enormous time cost only purchasing on the black market, thereby increasing the goods cost by several hundred per cent). However, such a severe lack of availability of artificial infant food may be unrepresentative, so these figures are not used in calculations. Instead, the time required simply to purchase the product through more normal sales outlets was estimated.

Estimates for time required for obtaining fuel for artificial feeding were based on the assumption that urban mothers depend more on purchasing and rural mothers depend more on gathering.

Washing and sterilizing utensils and preparing artificial feeds from boiled water will increase household water consumption and estimates assume that water is more readily available to urban families.

The puchase of additional equipment and utensils for artificial feeding require some time, assumed to be the same in rural and urban areas.

Education for artificial feeding was assumed to take longer in rural areas because of lower literacy rates and the less adequate kitchen facilities for which training must be provided. Figures used were based on estimates made by infant food company nurses experienced in training both rural and urban mothers to bottle feed.

The additional home health care associated with artificial feeding for urban mothers is assumed to require two hours per day for one week on three separate occasions per year (prorated over two years). For a rural infant, artificial feeding is more of a health hazard, and obtaining simple health care aids, etc. is more time consuming, so this figure is doubled. These estimates assume that the mother is putting in the minimum time and expense necessary to avoid malnutrition and severe disease from artificial feeding. If disease necessitated a visit to a health care facility, time would be required for transportation, waiting to be seen, staying with the infant if it were admitted to a hospital, etc., and thus time costs would greatly increase.

The time required to breast feed is only the mother's, but estimating the value of time used in artificial feeding requires a knowledge of who was participating. Then, as Popkin (1978) did for the Philippines, the value of time spent on artificial feeding by each person can be estimated according to his/her estimated or predicted wage rate.

This requires rather detailed data, which are not available for Ghana. However, estimates can be based on the findings of the infant feeding time study described on page 81. Of 61 artificial feedings recorded for 13 infants in Accra, 39% were given by the mother, 33% by a maid, 16% by a grandmother, 5% by other relatives, 3% by the father, and 3% by other children. It is assumed that this represents the distribution of time spent on all aspects of artificial infant feeding in both urban and rural areas. This allows for an estimate of the value of time spent on artificial infant feeding by all persons involved, using the data in Table 35.

The wage rate for a maid was estimated to be about N¢50 per month in cash and in kind in May, 1977, and was adjusted to December, 1976, by assuming that the consumer price index continued to climb at the rate it did during the last six months of 1976. Relatives were assumed to earn the estimated mean for women, as were the mothers. Grandmothers were placed at the estimated wage rate of an unemployed woman, above the "old and disabled" category, but the below the mothers. The children who participated in infant feeding had a mean age of 13 years, and because of increased educational opportunities, were assumed to have the same predicted wage rate as their mothers. Identical figures were used for the rural as for the urban population because of lack of data on who participates in infant feeding there. This may be a reasonable overall approximation, since the lack of low-wage maids in rural areas may be counterbalanced by the greater participation of young children in infant feeding.

ii. Results

The daily time spent on artificial feeding by Accra mothers is recorded in Table 33. (Also included are data on time spent for solid feeding, which are discussed in Appendix 3.) The data on time spent for artificial feeding are combined with estimates of time used for other activities associated with artificial feeding in urban and rural areas and reported in Table 36 on a weekly basis over a two-year period. The average total daily time for all of Ghana is also given. In Table 37, data on time spent on artificial feeding and the value of that time are combined to give a total time cost. The mean for the entire country is US$0.82 per day or $599.04 for two years of artificial infant feeding per infant.

e. Disease costs

As discussed in the case of the Ivory Coast, it was not possible to quantify the health benefits of breastfeeding or the disease costs of artificial feeding for the individual sufferer or his/her family.

f. Application of data to the model

Equation 12 stated that the incremental value of breastfeeding,

$$BF_i = (H_{bf} + D_{af} + \sum_n G_{af_j} + \sum_p T_{af_k}) - (\sum_m G_{bf_i} + T_{bf}).$$

TABLE 35: Rough Estimates of Value of Time in Ghana.

Type of economic activity	% of persons over 15 years of age	Typical annual income N¢	Hourly income (3)÷2000 N¢	Total (2)x(4) N¢	Rural N¢	Rural US$	Urban N¢	Urban US$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Female								
Wage Labor	1.5	1300	.65	.975				
Agriculture	33	900	.45	14.85				
Self-employed and other	27	800	.40	10.8				
Homemaker	26	(700)	.35	9.1				
Student	5.5	(1000)	.50	2.75				
Unemployed	2.5	(600)	.30	.75				
Disabled and old	4.5	(300)	.15	.675				
Average hourly income				.40	.38	.33	.43	.37
Male								
Wage Labor	16	2000	1.00	16.00				
Agriculture	46	1200	.60	27.6				
Self-employed and other	14.5	1100	.55	7.975				
Homemaker	1	(900)	.45	.45				
Student	12	(1300)	.65	7.8				
Unemployed	6.5	(800)	.40	2.6				
Disabled and old	4	(400)	.20	.8				
Average hourly income				.63	.61	.53	.69	.60

Column (2): major sources: Census Office (1972) and Central Bureau of Statistics (1970).

(3): rough estimates based largely on data in Hinderink and Sterkenburg (1975), adjusted for changes in value of currency (overall devaluation of the Cedi against the dollar from 1971 to 1976 of 11%), and for increase in consumer price index of 281% from average for 1971 to December, 1976. Sex differences estimated (see text). Numbers in in parentheses are estimates of predicted incomes if employed.

(4): 40 hours of work per week times 50 weeks per year equals 2000 hours per year

(6)-(9): Based on finding of Dutta-Roy (1969) in Eastern Region that the average urban household incomes were 1.13 times greater than rual incomes (included value of own produce consumed). Assumes 30% of population is urban (living in communities with more than 5000 inhabitants.

TABLE 36: Time Used in Activities Associated with Artificial Feeding in Ghana

	Minutes per week spent on obtaining goods inputs								Total time (minutes)	
	Feeding	Washing and preparation	Food	Fuel	Water	Utensils	Education	Additional home health care	per week	per day
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Urban	187	630	15	15	15	5	10	50	927	132.4
Rural	187	945	30	70	50	5	20	100	1407	201.0
Entire country									1263	180.4

For columns 6-8, time is prorated over a two-year period.

TABLE 37: Daily Time Cost of Artificially Feeding an Infant in Ghana.

Person feeding	Time spent feeding (minutes) T		Wage rate of person feeding N¢/hour WR		Cost of feeding N¢ $\frac{T \times WR}{60}$	
	Urban	Rural	Urban	Rural	Urban	Rural
Mother	51.6	78.4	.43	.38	.37	.50
Maid	43.7	66.3	.19	.19	.14	.21
Grandmother	21.2	32.2	.30	.30	.11	.16
Other relatives	6.6	10.1	.43	.38	.05	.06
Father	4.0	6.1	.69	.61	.05	.06
Children	4.0	6.1	.43	.38	.03	.04
Total	131.1	199.2			.74 US $0.64	1.03 US $0.90

Rough estimates for some terms in this equation, as calculated above for two years of infant feeding, are as follows:

$\sum_n G_{af_j}$ = ¢386 / 305 (Alternative A/B)

$\sum_m G_{bf_i}$ = 102/51 (Foutou/rice)

$\sum_p T_{af_k}$ = 599

T_{bf} = 211

Thus the equation reduces to the form

$BF_i = H_{bf} + D_{af}$ + ¢672/591 (Alternative A/B for foutou), or

$BF_i = H_{bf} + D_{af}$ + ¢724 / 642 (Alternative A/B for rice)

This suggests that for the average Ghanaian family, two years of breastfeeding would save between ¢ 591 and ¢ 724 over the cost of artificial feeding in goods and time costs, plus any additional goods and time costs of disease or malnutrition that might result from artificial feeding rather than breastfeeding.*

3. National Level

a. Establishing national infant feeding patterns

(1). Breastfeeding patterns

i. Method

Methodological issues involved in establishing national breastfeeding patterns are discussed on page 56, including a description of the method of data analysis used here.

ii. Results

Table 38 reports comparative figures on breastfeeding patterns from nine studies carried out in Ghana, including date, location of the study, sample size, median age of weaning (i.e., length of breastfeeding), and where available, median age of introduction of supplemental food (i.e., length of exclusive breastfeeding). This data suggest that there was little decline in rural areas during the 1960's and little decline in rural areas from the mid-1950's to the mid-1970's. Although there is no evidence of a change over time, there is a distinct difference between rural and urban areas throughout the entire period. The mean of the weaning ages for the 12 rural studies in Table 38 is about 1½ years (18.8 months), while that for the 5 urban studies is about 1 year (12.2 months).

*The reader is reminded that this assumes a "normalization" of the economic situation in Ghana, such that the relative costs of staple foods and imported infant foods approach those found in the Ivory Coast.

TABLE 38: Approximate Median Ages of Supplementation and Weaning in Ghana

Reference	Date carried out	Location	Sample size	Median age of supplementation (months)	Median age of weaning (months)
Grant, 1955b	1954	Dome, Mampong: rural	34	9.5	19.7
Davey, 1961a[1/]	1961	All Ghana	2463		17
		South, fishing vill.: rural		(3.7)	18.4
		South, farming vill.: rural		6.5	17.6
		South towns: urban		7.7	13.0
		South Accra/Kumasi: urban		(2.6)	11.6
		North: rural		(10)	(24)
Harrington,[2/] 1971	1965-66	21 vill's, all Ghana: rural	4485		17.8 (uned)
		21 vill's, all Ghana: rural			15.5 (educ)
		Accra: urban	4549		14.5 (uned)
					10.2 (educ)
Nutrition Unit, 1968	1967 ?	Tefle: rural	100	3.6	11.9
Dovlo, 1968	1967 ?	Accra: urban	399	4.3	11.9
Steckle, 1972	1970	Vane: rural	65		22.6
		Juapong: rural	44		18.0
Dako and Watson, 1972	1972	Baafi: rural	42		20.0
Van der Mei & Belcher, 1974[3/]	1972	Agogo area: rural	?		18.9
Commey & Anang, 1975	1974	Adzen Kotoku: rural	260		21.1

Numbers in parentheses are estimates based on extrapolations from available data. Other values are interpolations.

1/ Based on the National Nutrition Survey, carried out on a stratified random sample of the country, including 2463 infants under 2 years old. Sizes of subsamples not reported.

2/ Based on stratified random samples of Accra and 21 rural villages throughout Ghana. Values estimated from graphs in Harrington (1971:191). Data were reported according to whether or not the mother was educated

3/ Based on a systematic sample of households in 6 villages. Total sample size was 1610, but no indication was given of how many infants the breastfeeding data were based on.

(2) Artificial feeding patterns

i. Method

Data sources for establishing national artificial infant feeding patterns are discussed on pages 60-63. Little data on patterns of artificial infant feeding in Ghana can be obtained from surveys, though Dovlo (1968) contains some. However, some indication of the extent of artificial feeding can be gotten from examining the availability of various milk products. This is particularly true in a country such as Ghana, where the availability of all types of milk is severely restricted. Possible methods for using data on milk availability to estimate the extent of artificial feeding in the country are illustrated through a number of calculations.

ii. Results

Table 39 shows estimates of the annual milk production in Ghana as well as the quantity and value of various types of imported milks from 1961-1975. These quantities are placed in context in Figure 4 which shows the number of calories available per person per day for each type of milk.

Fresh milk consumption is restricted to a small population of Fulani herdsmen in the North and to elites in urban areas who obtain it occasionally from experimental dairy projects or from limited imports. Sterilized milk has been produced locally since 1959 from dried skim milk and butterfat or vegetable fat. Average daily production in 1973 was 600 gallons per day (Ofosu, 1974), which would amount to about 790 metric tons (MT) in 365 days.

Sweetened condensed milk and evaporated milk have been imported in small and decreasing quantities since 1972. This is partly because of the crisis in balance of payments which began in that year, but it was also the year of the completion of a factory in Ghana for the production of evaporated milk from dried skim milk (DSM) and butter oil. Thus, while the availability of sweetened condensed milk has been severely reduced (only 2 MT was imported in 1975), the availability of evaporated milk has remained relatively constant. Local production for 1973-1975 is shown in Table 39. In 1976 it rose to 21,653 MT.

During interviews in mid-1977, both health professionals and infant food company personnel felt that almost all infants in Ghana who were artificially fed received infant formula. The situation described above suggests that fresh milk and sweetened condensed milk are not consumed by infatns, if only because they are very restricted in availability. Apparently evaporated milk has not come to be widely perceived as a potential replacement for breast milk."

The import category "dry milk" is composed of (1) infant formula, (2) dry skim milk, and (3) dry whole milk. The import statistics appear to include milk donated to Ghana as foreign aid. Large amounts were received from the US in 1963-1965 (Reusse, 1968), and continued at levels on the order of 1000 MT per year until 1973 when it was halted. (Chinery-Hesse, 1974).

*The Ghana Standards Board had required that the label on the locally manufactured tins of evaporated milk carry an infant feeding schedule, but the manufacturer had requested and received permission to remove the schedule from the label, and as of the summer, 1977, new labels were being printed.

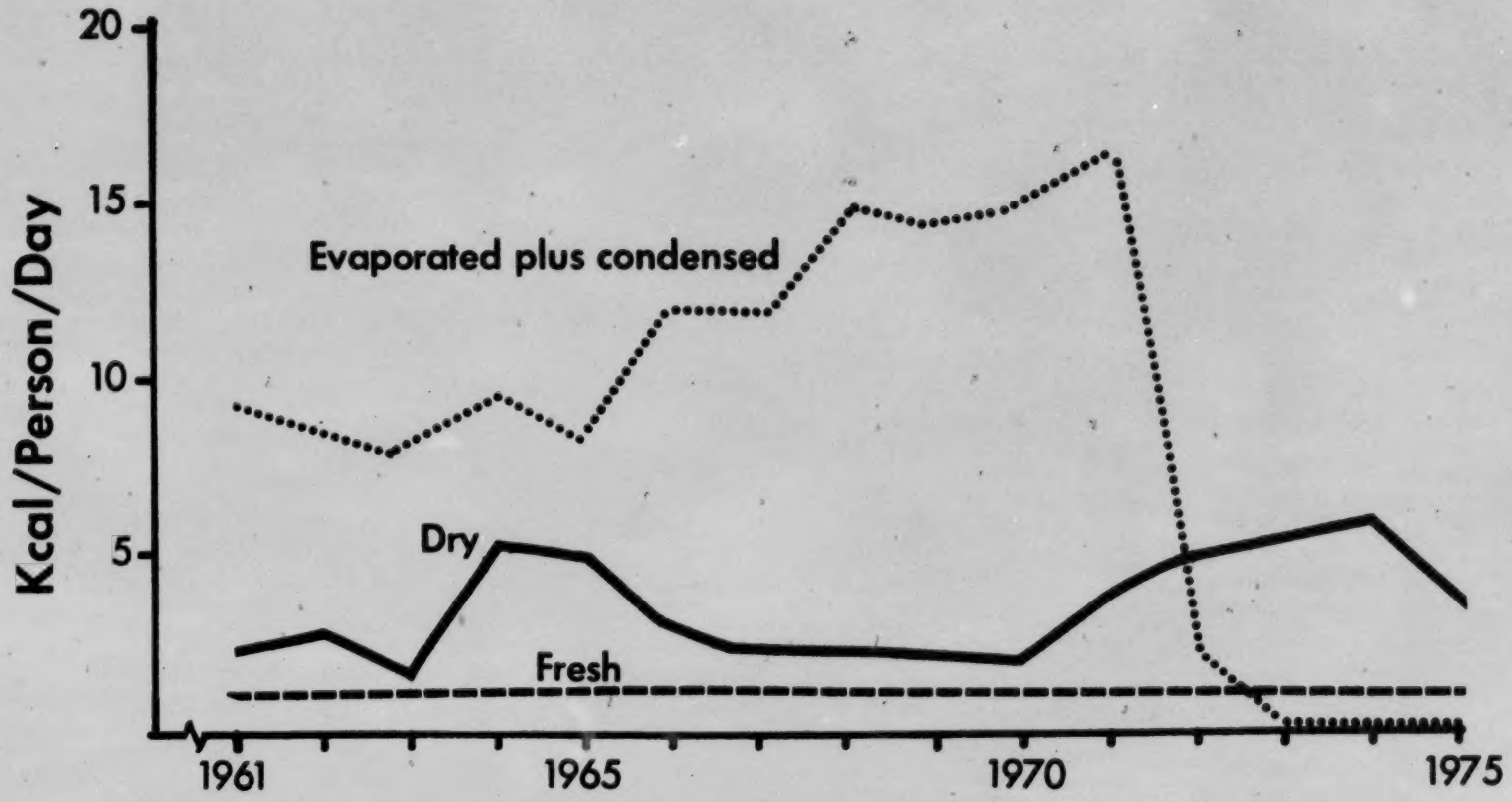
TABLE 39: Milk Production and Import for Ghana, 1961-1975.

Year	Fresh Local* (MT)	Fresh Imported (MT)	Fresh Imported US$ 000	Local Evaporated** (MT)	Evaporated/ Condersed (MT)	Evaporated/ Condersed US$ 000	Dry (MT)	Dry US$ 000
1961	4125	389	156		10360	3878	1750	748
1962	4538	271	110		9930	3595	2010	745
1963	4950	245	90		9460	3721	1353	886
1964	5775	245	99		11660	3818	4169	1002
1965	6188	268	113		10400	4101	4020	1206
1966	6188	267	92		15157	6047	2417	898
1967	6600	309	99		15399	5307	2001	965
1968	7013	158	56		19512	5156	2032	989
1969	7013	360	112		19445	5966	2000	1152
1970	7450	153	84		20706	7240	1936	1429
1971	7697	83	35		23309	7764	3757	2296
1972	7937	78	45		3520	1847	4902	2498
1973	7700	103	42	18565	584	418	5336	3972
1974	7524	100	58	19740	433	312	6178	6964
1975	7700	36	20	17453	18	21	3950	4555

Sources: St. System Turn Around Document, April 1, 1976. Unpublished data made available by FAO.
1975: Calculated from Ghana Central Bureau of Statistics, External Trade Statistics, Vol 25, No. 12, 1975 (Based on N¢ = US $0.87 and 1 metric ton (MT) = 19.684 CWT)

*Estimates
**Sales data, Food Specialties, Ltd., Ghana

FIGURE 4: Milk Consumption in Ghana.



Source: FAO Statistical Division, Food Supply Analysis (first output), April 1, 1976.
Unpublished dates made available by FAO.

1975 Data: Calculated from Ghana Central Bureau of Statistics,
External Trade Statistics of Ghana, vol. 25, Nov. 12, 1975.

The World Food Program (WFP) has given out relatively small quantities of DSM, though this has increased in recent years to the level of a few hundred MT per year (Proja-Ronchi, 1977).

In the past, the majority of dry milk has been used for institutional feeding and for industrial purposes (Reusse, 1968). Asiedu (1967) estimated the quantity used for infant feeding to be about 28% of the total. However, since 1972 virtually all imported powdered milk (except infant formula) must have been used to produce sterilized milk (100 MT of dried milk to produce an estimated 800 MT of sterilized milk annually) and evaporated milk (1 MT of dried milk for every 4 MT of evaporated milk listed in Table 39).

Therefore, Ghana, in recent years, may be in a unique situation such that the quantity of formula imported quite closely reflects the entire quantity of breast milk substitute used.* This would allow relatively reliable boundaries to be placed on the quantity of breast milk intentionally substituted by artificial infant foods. (Of course, many other foods could be used to substitute for breast milk in older infants, and even for younger infants, though with a risk to their health. There could also be an involuntary substitution effect of supplemental foods.) Somewhat less reliable estimates could also be made from this data as to the total number of artificially fed infants in the country in 1976.

Since most of the infant formula imported into Ghana is not the low solute type, it is assumed that the caloric density is the same as that of full cream powdered milk, 502 kcal/100gm (Watts and Merrill, 1963, item #1326). Approximately 56.7 kg of powdered infant formula would be required to replace breast milk for two years for one infant. Then the 225 MT of infant formula imported in 1976** would entirely replace breast milk for only 3966 infants. Assuming a birth rate of 49.5 per 1000 population (Gaisie, 1976:74) and a population of 9.8 million (mid-1975 estimate from Population Reference Bureau, 1976), there were about 485,100 births per year in the mid-1970's. By one year of age, 13.3% of these infants would have died, and this would increase to 14.7% by age two (Gaisie 1976:155). Therefore, the average number of live infants in the first year would be $485{,}100 - \frac{.133}{2}(485{,}100) =$ 452,841 and in the second year, $485{,}100 - (485{,}100)(.133) - (485{,}100)\frac{.147-.133}{2}$ = 417,186, or a mean of 435,014. The 3966 infants for whom breast milk could be entirely replaced by infant formula for two years, represent only .91% of these infants.

Perhaps a more realistic minimum for the number of infants actually receiving infant formula could be based on the assumption that 50% of the breast milk was replaced during the first four months, 75% from 4-12 months, and 100% from 12-24 months. This would mean that 44.7 kg of formula were used per child and the available formula would feed 5034 infants, or about 1.2% of Ghana's infants. It is more difficult to set a maximum boundary on the number of infants who might receive at least some amount of infant formula. Perhaps one way to do this is to examine the results if every infant received

*Another factor which simplifies this analysis for Ghana is that the population of non-African expatriates has remained very low for the last several years.

**Calculated by the authors from sales data obtained from all companies importing infant formula in Ghana in 1976.

only 2 kg of formula. This would meet the average daily caloric need of a 0-4 month old infant for 18.5 days at full strength or for 74 days if diluted to one-fourth strength or used as one-fourth of the required calories. The 225 MT of formula could supply 2 kg to each of 112,500 infants, about 26% of Ghana's infants.

The 225 MT of infant formula imported in 1976 represented a conscious limitation because of lack of foreign exchange. For 1977 the Ghana National Procurement Agency asked for bids from infant food companies to meet the actual estimated demand (based on information supplied to them by the companies which had been operating in Ghana). This came to a total of 1481 MT*. However, one infant food company said that their market research showed that total demand could come to 871 MT. This increase in availability of infant formula could have striking effects in terms of the number of infants for whom at least some breast milk could be substituted. For example, if 25% of breast milk intake for the two years were replaced by infant formula, 225 MT of infant formula would reach 3.4% of Ghana's infant, 871 MT would reach 13.3%, and 1481 MT would reach 22.6%.

b. Economic impact of hypothetical changes in infant feeding pattern

i. Method

All else being equal, breastfeeding will probably decline as urbanization accelerates in Ghana. Many researchers feel that rural-urban migrants are especially susceptible to such factors as the high status of bottle feeding or its commercial promotion, and consequently change from breast to bottle rather rapidly (Jelliffe and Jelliffe, 1970; Sai, 1967). Others (e.g., Hakim, 1977) even suggest that there may in fact be little decline in breastfeeding in the Third World, except to the extent that increasing urbanization extends the environment in which bottle feeding is the norm. The following section will explore the economic implications for Ghana if this hypothesis were true. That is, if breastfeeding remains constant in both rural and urban areas at current levels, what will be the economic impoact if rural-urban migrants switch from the rural to the urban breastfeeding pattern?

To adequately characterize and compare breastfeeding in rural and urban areas, it would be desirable to have longitudinal data on large randomly chosen samples, reported in a relatively disaggragated way. Instead, it was necessary to choose those cross-sectional studies which had samples as large and representative as possible. Those chosen were Dovlo (1968) for urban and Steckle (1972) for rural areas. Dovlo interviewed mothers of 399 infants attending one of two clinics or the out-patient department of one hospital, all in the capital and largest city, Accra. Steckle interviewed husbands and wives in 72 households (obtaining weaning ages on 65 infants), in Vane, a traditional farming village in southeast Ghana. Both studies reported weaning ages, but they used different age categories.

A graph of cumulative weaning ages, as described on page 56, was used to quantify the total impact of a change in the weaning pattern. The difference in the area under each curve, that is, the area between them, was then measured. One method was to count the number of squares between them (and calculate the areas of triangles formed by diagonal lines). Another method was carefully to cut out that portion of the graph paper and weigh it on an analytical balance to .0001 gram.**

*Infant formula was included in categories "Infant milk" and "Special Baby Food."

**The two methods gave findings that differed by only 3% from each other. Therefore, the counting method would suffice if an analytical balance were not available.

The accuracy of this approach would increase as an increased number of data points (i.e., smaller age categories) more precisely defined the shapes of the curves. This is particularly true at the top and bottom of the curves where it may be necessary to extrapolate to 100% and 0% (or % weaned from birth) by extending the line segment which connects the last two data points at each end, represented by dashed lines.

In order to use the graphs to measure the economic impact of the change in weaning pattern, the following meanings were assigned to the axes: (1) The ordinate stands for the percentage weaned of the infant population concerned. This population will consist of all infants born during a one-year period to families who moved from a rural to an urban area during a one-year period, around 1970. It is assumed that the weaning pattern for these infants will change from that found in Vane to that found in Accra. K. T. De Graft-Johnson (1974:474) calculated that, while the total population of Ghana grew at the rate of 2.4% per annum from 1960-1970, the urban population grew 4.8%. Therefore, it will be assumed that the number of migrants to urban areas during one year at about 1970 was 4.8 - 2.4 = 2.4% of the urban population at the time (.024 x 2,472,456 = 59,339). Assuming that the birth rate in this migrant population is 49.5, the same as that for Ghana as a whole* (Gaisie, 1976:74), there would be 2937 births in one year to rural-urban immigrants, and each percentage point will stand for 29.37 infants. (2) The abscissa would represent the quantity of infant formula needed to substitute for a daily breast milk output of 722 ml from 0-4 months, 600 ml from 4-12 months, 400 ml from 12-24 months, and 300 ml beyond 24 months of age. Based on a caloric density of 502 kcal/100gm for infant formula (page 95) each month between 0-4 would represent 3.24 kg of infant formula per infant. Between 4-12 months, each month would stand for 2.69 kg, 12-24 months would be 1.79 kg and beyond 24 months, each month will be taken to represent 1.34 kg.

ii. Results

Weaning ages for the urban area (Dovlo, 1968) and the rural area (Steckle, 1972) are listed in Table 40, according to the age categories used by the investigators. The cumulative percentages of infants weaned at each age are also given. These cumulative percentages are then plotted for both studies in Figure 5.

Using the weighing method, the quantities of infant formula required to substitute for the shift from a rural to an urban pattern of weaning among immigrants would be .6505 MT for the period from 0-4 months, 7.7887 MT for 4-12 months, 31.1096 MT for 12-24 months, and 9.2607 MT for 24+ months. This represents a total of about 49 MT of infant formula, about 22% of that imported in 1976. At 1976 cif prices, this would cost about $147,840.

This loss in foreign exchange due to urbanization can be compared to that which would be lost if the current restrictions in availability of infant formula were eased. Based on 56.7 kg of powdered infant formula to replace breast milk for two years for one infant, and a cohort of

*A lower birth rate might be expected in the migrant population, since the ratio of males to females is higher. However, since the proportion of elderly persons and children is lower, the total percentage of the population composed of women of childbearing age may be similar.

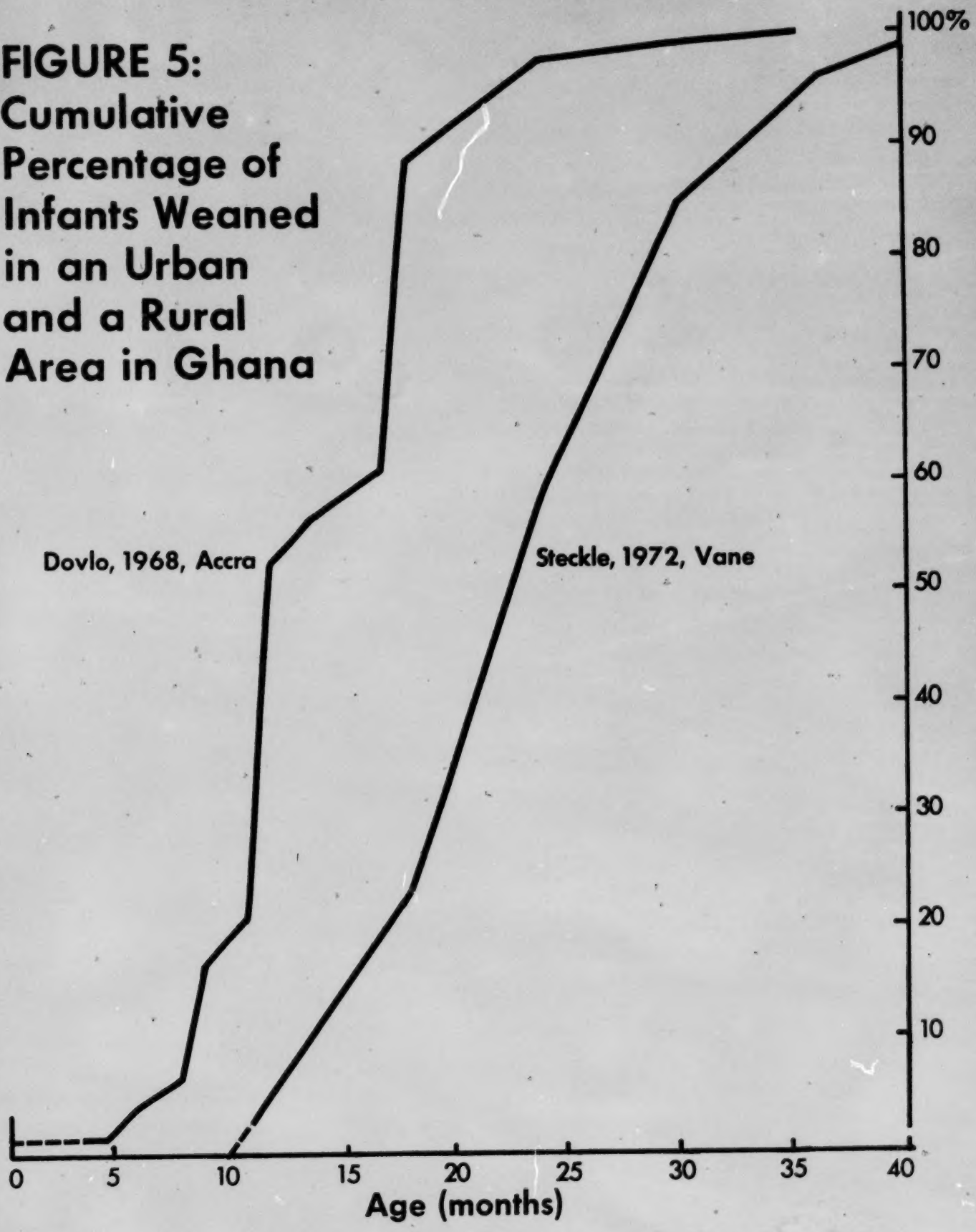
TABLE 40: Weaning Ages in One Urban Area and One Rural Area in Ghana

Age of weaning[1] (months)	N	%	Cumulative percentage
Dovlo, 1968,[2] Accra			
3	7	1.8	1.8
5	1	0.2	2.0
6	8	2	4.0
8	12	3	7.0
9	40	10	17.0
11	18	4.6	21.6
12	123	30.8	52.4
14	18	4.5	56.9
17	17	4.3	61.2
18	109	27.3	88.5
24	36	9	97.5
30	6	1.5	99.0
36	4	1.0	100.0
	399	100.0	
Steckle, 1972, Vane			
12	3	4.6	4.6
18	12	18.5	23.1
24	23	35.4	58.5
30	17	26.1	84.6
36	7	10.8	95.4
42	3	4.6	100.0
	65	100.0	

1/ Breastfeeding was discontinued on or before the age given.

2/ Excludes 10 highly educated women chosen by Dovlo in addition to the clinic samples.

FIGURE 5: Cumulative Percentage of Infants Weaned in an Urban and a Rural Area in Ghana



435,014 infants (p. 95), would require 24,665 MT. Thus if an increased availability of infant formula led to its replacing only 1% of the potential two-year national breast milk production, the cost would be about five times as high as that due to urbanization (247 MT compared to 49 MT of powdered infant formula).

c. Cost of malnutrition resulting from artificial feeding

(1) Extent of protein-calorie malnutrition

In Ghana the health-producing effects of breastfeeding and the disease-producing effects of artificial feeding probably make up a major share of the incremental value of breastfeeding. The paucity of relevant data make it impossible to calculate the monetary value of these health effects. In any case, it is questionable whether human suffering and death can be transformed ethically into monetary figures.

Most measures of morbidity in Ghana are records of hospital and clinic attendance (e.g., Simic, 1971:29; Ministry of Health Planning Unit, 1977) and notification of infectious diseases (Central Bureau of Statistics, 1970:29-30). These figures are themselves gross underestimates of morbidity and especially of the role of malnutrition. They suggest that the other major health problems among young children are malaria, gastroenteritis, bronchitis, upper respiratory infections and measles.

Perhaps the best estimate of infant mortality (0-1 year) is 133 deaths per thousand live births for the entire country, with a rural rate of 161 and an urban rate of 98 (Gaisie, 1976:155). Of all infants born in Ghana, a minimum of 14.7% die before 2 years of age, 16.5% by 3 years and 18.7% by 5 years (Gaisie, 1975:28).

Malnutrition, even when it is not severe, reduces a child's resistence to disease. It is estimated that among children under five in Ghana, "70 per cent of deaths are due to infections and parasitic diseases which are usually aggravated by malnutrition" (Ministry of Economic Planning, 1977:367).

In a study of autopsies performed on 373 children who died between ages 0-14, malnutrition was found to be the number one cause of death, and gastroenteritis was the sixth highest cause (Christian, 1967). Among 11,500 certified deaths in compulsory registration areas throughout the country, malnutrition was the major cause in 13.1% and gastroenteritis in 5.4% (Medical Services, 1967:19, 31).

Data on the prevalence of infant and young child malnutrition from a number of studies in Ghana are shown in Table 41. It appears that severe malnutrition (less than 60% of the standard weight for age) is most prevalent from 6-24 months of age, and moderate malnutrition (between 60-80% weight for age) is very widespread in children under five years old. The problem appears to be worse in the north, where Gordon (1976a) feels that it has deteriorated in recent years, as drought has led to several crop failures.

In the National Food and Nutrition Conference (Ofosu-Amaah, 1974a), several estimates of the extent of malnutrition were given. In the workshop on "improving the nutritional status of the preschool child and mother," it was es-

TABLE 41: Prevalence of Malnutrition in Ghana.

Reference	Date carried out	Location	Sample size	Age Group	% of sample <80% wt/age*	Other criteria
Dako & Watson 1974:309	1972	Baafi, rural south	13 49	1 yr 1-5 yr	38 39	
Commey & Anang 1975:53	1974	Adzen Kotoku rural south	12 17 108	0-6 mos 7-11 mos 12-59 mos	0 59 55	
						% with PCM
Gordon 1973b:9	1969	Bawku District rural north	494	0-6 mos 7-11 mos 12-23 mos 24-35 mos 36-47 mos 48-60 mos		7.6 21.9 15.0 6.2 3.6 3.0
						"Underweight"
Gordon 1976a	1973 1976	Bawku District "	? ?	under 5 "		40 60
Delahaye 1977	Dec 76-Jan 77	Bawku District	1585	"	49.5	
	Feb-Mar 77	"	1152	"	38.6	
	Mar-Apr 77	"	787	"	53.4	
						Median % wt/age*
	Nov-Dec 76	East Bawku District	1226	"		79.4
	"	West "	801	"		79.1
	Jan-Feb 77	East "	1184	"		86.4
	"	West "	614	"		79.0
	Mar-Apr 77	East "	977	"		81.7
	"	West "	654	"		78.3
	May-June 77	East "	1324	"		78.9
	"	West "	820	"		77.4

*Per cent of standard (50th percentile) weight for age, Harvard Standards, sexes combined.

TABLE 41: (Continued)

Reference	Date carried out	Location	Sample size	Age group	% of sample <80% wt/age*	Other criteria
						% of sample <60% wt/age*
FAO, 1976**	1961	All Ghana	?	0-1 yr	28	5
"	"	"	674	1-2 yr	35.4	6.3
"	"	"	1078	2-3 yr	25.9	2.2
"	"	"	1031	3-4 yr	15.7	0.4
"	"	"	972	4-5 yr	11.4	0.1
"	"	North Ghana	?	2-5 yr	32.6	
"	"	South Forest	?	2-5 yr	23.3	
"	"	Coastal Plain	?	2-5 yr	9.1	
"	"	South Urban	?	2-5 yr	14.5	
"	"	South Rural	?	2-5 yr	20.0	
						Mean % wt/age*
"	"	"	?	1-5 yr		89.0
"	1970's	"	?	1-5 yr		87.5
"	1961	South Urban	?	1-5 yr		91.7
"	1970's	"	?	1-5 yr		89.4

*Per cent of standard(50th percentile) weight for age, Harvard Standards, sexes combined.

**Uses data from the 1961 National Nutrition Survey and from several recent studies.

timated that 35-40% of preschool children in Ghana are underweight (Ofosu-Amaah, 1974a:175). Baddoo (1974) estimated that between 18-24 months of age, 40-50% could be considered undernourished and that about one-fourth of them actually develop clinical malnutrition. Ofosu-Amaah (1974b) estimated that, among children under 5 years old, the point prevalence of kwashiorkor was about 1-2% (and the incidence per year would be several time this high) and that the incidence of marasmus was about 1-2% per year. The Ministry of Health Planning Unit (1977:49) estimates the incidence of kwashiorkor plus marasmus as 1.4 per 1000 preschool children per year. The Ministry of Economic Planning (1977:368) estimates that "one in ten children passes through a stage when they can be described as clinically malnourished and four out of ten pass through a period when their nutritional status is borderline."

It is extremely difficult to determine the extent to which a failure to breast feed optimally is a causative factor in infant malnutrition, morbidity, or mortality. One possible approach is illustrated by Knodel (1977). Using data on rates of breastfeeding and of infant mortality by province in Bavaria in 1900-1906, he developed a regression equation which suggests that a 10% reduction in mothers who breast fed was associated with an increase in 21 infant deaths per 1000 births. However, this requires detailed data by region, not available in most places, including Ghana.

It does appear, however, that prolonged breastfeeding is associated with increased survivorship. Data presented in Table 42 suggest that infants weaned before one year of age in an urban area and before 18 months in a rural area suffer from higher mortality rates. This bivariate association probably underestimates the true importance of extended breastfeeding because it fails to control for the fact that mothers in poverty situations (or in the North where environmental conditions are particularly severe) tend to breast feed longer. This might explain the slightly lower survivorship among offspring of rural mothers who breast feed for longer than 2 years.

The use of artificial feeds, even when combined with breastfeeding, appears to be a causative factor in many cases of malnutrition. Boohene (1974) mentions it as an important problem in a nutrition rehabilitation center in Accra, especially among migrants from rural areas. In a study of 86 cases of malnutrition carried out in 1970, in Accra, Commey (1975) found that 20% had been weaned before 6 months of age. This can be contrasted with Dovlo's (1968) study of children in which less than 5% were weaned by that age. In a more recent study of 30 cases of malnutrition in Accra, Gomez (1976) found that 60% had been partially bottle fed. In most cases the bottle had been introduced from 1-3 months of age. When asked what milk was best, 33% of the mothers said breast milk, 10% said powdered milk, and 43% said both.

The age at which malnutrition develops can serve as one indicator of the role of early weaning in causing it. Rarely will malnutrition appear in an infant under 6 months if he or she is exclusively breast fed. In Ghana it appears that less than 10% of the malnutrition in rural areas (Gordon, 1976b; Commey and Anang, 1975) and 10-20% of the malnutrition in urban areas occurs in infants under 6 months of age (Boohene, 1974; Commey, 1975; Gomez, 1976).

(2) Cost of malnutrition

The Ministry of Health Planning Unit of Ghana (1977) has developed "a method for measuring the relative importance of diseases to a population as

TABLE 42: Proportion Surviving of Children Ever Born by Length of Breastfeeding in Ghana.

Proportion of children surviving	Length of Breastfeeding (months) 0-11	12-17	18-23	24-29	30-35	36 +
In Accra						
(N = 4549 births)	.627	.875	.885	.864	---	.993*
In rural areas						
(N = 4485 births)	.279	.785	.866	.753	.868*	.764

Source: Harrington, 1971.

*Based on less than 45 births. Empty cell based on less than 10 births.

TABLE 43: Relative Importance of Diseases in Ghana, Measured by "Days Lost" to the Community Resulting from Each Disease

Disease	Days lost per year
Malaria	54,134
Diseases of the newborn	42,312
Kwashiorkor and marasmus	17,757
Measles	13,373
Gastroenteritis	11,123
Cancer	10,607
Tuberculosis	10,047
Cerebrovascular	5,517
Complications of pregnancy	5,500
Polio	5,348
Schistosomiasis	3,844
Common cold	1,500

Source: Ministry of Health Planning Unit (1977)

a basis for allocation of health resources." In effect, it combines data on morbidity (partial and total handicap) and mortality (compared to life expectancy) to estimate the loss to the community in "days of effective life" each year, resulting from a given disease. Their findings, shown in Table 43 show that malnutrition and gastroenteritis take the third and fifth highest toll in terms of "days lost."*

Perhaps the most highly visible cost of malnutrition to society, though it represents only a small proportion of the total social cost, is the rehabilitation of malnourished children. A number of estimates on this cost per in-patient (IP) and out-patient (OP) have been made in Ghana for three types of facilities, hospitals, health posts, and nutrition rehabilitation centers, and are presented in Table 44. The calculation of such estimates is a very complex undertaking and of necessity involves making a number of assumptions and masking a great deal of variation. In many cases much desirable data is lacking and that which is available is of questionable reliability. Overall, most of the data probably underestimate total costs.

It is difficult to adjust costs for inflation in Ghana. The consumer price index was used to standardize costs to December, 1976 price levels. In a few cases this could be compared with adjustments made locally on the basis of more information (shown in parentheses). This showed that the consumer price index overestimated the cost increases, but it still provides a convenient way of comparing relative costs.

According to Morrow (1977), a typical outpatient visit cost N¢ 2 (US $1.00 = N¢ 1.15) excluding capital costs, land value and rent, while a typical inpatient day, with drugs excluded as well as the above, is N¢ 20. Drug costs averaged 50% of total costs for 26 hospitals and health centers in the Eastern Region (Calculated from Brooks, 1977a:7). Therefore, the estimated cost per IP day must be raised to N¢ 40. A good estimate for the IP cost of nutrition rehabilitation center, based on data from Bawku (Table 44, footnote 6), might be N¢ 3 per day.

Two additional types of data are needed in order to estimate the cost of rehabilitating all of Ghana's malnourished children. First is the length of time required by each of the three rehabilitation methods for varying degrees of severity of malnutrition. Second is the prevalence of these degrees of malnutrition.

The average duration of stay for pediatric admissions in five regional hospitals in 1966 was reported to be 7.3 days (Ministry of Health, 1967). However, this includes many diseases which require less time to rehabilitate than malnutrition. In the Bawku nutrition rehabilitation center, the average duration of stay was 20 days in 1974-75 (Gordon, 1976a), and even then, there

*In the case of death, this can perhaps be thought of most appropriately as representing the cost to the individual sufferer. As far as public or parental costs are concerned, all days for an individual cannot be considered equal. Goods and time investments made on an individual cumulate from birth. At a certain age, the investments being made are outweighed by returns which that individual's productivity makes to his/her parents or society. Before that turning point, it must be said that the older the individual is, the more expensive his/her death is to parents or society.

TABLE 44: Estimated Costs per Patient-day for Various Health Facilities in Ghana.

Type of facility	Location	Year	Approximate cost per IP day or OP visit N¢	Cost adjusted 1/ to Dec., 1976 N¢	Explanatory footnote number
Hospital-IP	Cape Coast	1972/73	9.34	29.80	2
Hospital-OP	Cape Coast	1972/73	.66	2.11	2
Hospital-IP	Saltpond	1972/73	9.98	31.84	2
Hospital-OP	Saltpond	1972/73	.74	2.36	2
Health Post-OP	Kissi	1972/73	.47	1.50	2
Hospital-IP	East. Reg.	1974/75	31.45	68.33 (52.68)	3
Hospital-OP	East. Reg.	1974/75	1.57	3.43 (2.63)	3
Health Centre-OP	East. Reg.	1974/75	1.62	3.52 (2.71)	3
Health Post-OP	Danfa	1975	2.98	5.73 (4.48)	4
Hospital/ Under-Fives Clinic-OP	Agogo	1972	.27	.94	5
Mobile Satellite Clinic-OP	Near Agogo	1972	.24	.83	5
Nutrition Rehabilitation Centre-IP	Bawku	1974/75	1.55	3.37	6
Polyclinic/ Nutrition Rehabilitation Centre-OP	Kotobabi/ Accra	1974	.80	2.00	7

From 1972-1976, N¢ 1.00 = US $0.87; IP= In-patient, OP = Out-patient

Footnotes (Table 44)

1. Costs adjusted according to Consumer Price Index, Central Bureau of Statistics, 1977. For costs in parentheses, see appropriate footnotes.

2. Brooks, 1975. For Cape Coast Hospital, estimates of cost varied from N¢ 10.98 to 8.49 per in-patient day and from N¢ 1.00 to 0.46 per out-patient visit, depending on (1) source of data for number of admissions, (2) whether an OP visit was weighted as equivalent to one-tenth or one-twentieth of the cost per IP day, and (3) whether or not staff-training costs were included. The average length of IP stay was assumed to be 7.7805 days. For Saltpond Hospital, estimates of cost varied from N¢ 11.05 to 9.01 per IP day and from N¢ 0.98 to 0.51 per OP visit depending on (1) whether bed occupancy was assumed to be 90% or 100%, and (2) whether an OP visit was equivalent to one-tenth or one-twentieth of an IP day.

3. Brooks, 1977a and 1977b. These data include only recurrent costs; no capital costs were included. Wherever possible, costs attributable to community health and environmental health work were omitted. The data are preliminary because of unsolved problems concerning bed occupancy. The average length of IP stay (nonmaternity) was about 6 days (range 5.11-8.77 for five hospitals). Cost estimates are means for five hospitals and 19 health centres. Ranges were N¢ 46.82 to 19.95 per IP day and N¢ 2.34 to 1.00 per OP visit for the hospitals and N¢ 2.92 to 0.85 per OP visit for the health centres. Brooks (1977b) suggested that the data for 1974/75 could be increased by 60-75% to obtain estimates for 1976/77. Although inflation was more rapid than this, "certain costs were held down, in particular public sector wages and salaries were basically unchanged from July, 1974 to July 1977" (Brooks, 1977b). A lower rate of increase (67.5%) was therefore used to calculate the adjustment figures placed in parentheses.

4. Ministry of Health National Planning Unit (1977:62). Costs per patient contact during calender year 1975 (including three satellite clinics) for Danfa Comprehensive Health and Family Planning Project. Cost in parentheses represents the Planning Unit's adjustment to December, 1976.

5. Van der Mei and Belcher (1974). These clinics have more of a preventative than a rehabilitation function (and thus lower costs).

6. Calculated by the authors from data in Gordon (1976a). Includes costs for food, drugs, salaries, maintenance, depreciation on building and equipment, minus fees received, all divided by the number of child days. Average period of stay was 20 days.

7. Osei-Yaw, 1976. Includes cost of food, including value of aid received, salaries, and transportation, but not capital costs or drugs.

was a great variation in the extent to which rehabilitation was complete upon discharge. No data could be found on the influence of severity of malnutrition on duration of stay. Calculations will be based on 10 and 30 days' duration in order to cover a reasonable portion of the spectrum.

Based on the data reviewed on page 100, a reasonable estimate of the annual incidence of clinical malnutrition among children under five years of age in Ghana might be 2 per cent. The 1970 census reported a population of 1,563,130 for birth to 4 years of age (Census Office, 1972). Assuming that this segment of the population grows at the same annual rate of 2.7% as the population as a whole (Population Reference Bureau, 1976), by 1976 the number of children under five would have risen to about 1,834,000. The incidence of malnutrition among under fives in 1976, then would have been about 36,680 new cases. No estimate is available for the proportion of these who were actually treated in any way, but it is undoubtedly the minority.

Based on the data reviewed on pages 103-104, it might be estimated that 10-25% of the malnutrition in Ghana would be avoided if optimal breastfeeding were practiced (assuming no change in supplementation practices). The estimated cost to rehabilitate all these cases is presented in Table 45, according to various assumptions about the type of facility involved, the duration of the rehabilitation, and the per cent of malnutrition due to artificial feeding. Obviously, these are rough estimates. But two other crucial points must be kept in mind in interpreting these data (1) rehabilitation represents only a portion of the costs of malnutrition to society (and does not include most of the cost to the victim and his/her family), and (2) these relatively low costs directly reflect the relatively low levels of artificial feeding practiced in Ghana (see pages 95-96).

d. Lactation amenorrhea

Ghana's fertility rate is among the highest in the world. The crude birth rate is about 49-51 per thousand population, and the total fertility ratio is about 6.7 - 7.1 (Gaisie, 1976:155). This has long been a matter of great concern to planners in Ghana, and in 1969 it became the first country in West Africa to formulate a national population policy (Republic of Ghana, 1969). A year later, the Ghana National Family Planning Program was initiated and by April, 1975, a cumulative total of 138,000 new acceptors had come to government clinics. An equal number may have been recruited by private clinics and another 100,000 may not have been reported because of incomplete recordkeeping (Population Reference Bureau, 1976). If, in fact, there had been 376,000 family planning acceptors this would represent 21% of the females between 15 and 44 years of age in 1970 (calculated from Census Office, 1972). However, Gaisie and Jones (1970) estimated that less than 5% of fertile Ghanaian women were using modern methods of family planning. Furthermore, studies often find that a majority of family planning acceptors discontinue the use of contraceptives after some time.

Although family planning has made significant progress in Ghana, it will be some time before a significant reduction in fertility can be achieved. Caldwell (1968) found that in rural areas the family size felt to be ideal averaged 7.5 children, and even among urban elites it varied from 4.3 to 6.1. Based on the National Demograph Sample Survey of 1968/69, Gaisie (1973) re-

TABLE 45: Potential Approximate Cost of Rehabilitating Malnutrition Due to Artificial Feeding in Ghana in 1976

Duration of rehabilitation in days	Per cent of malnutrition due to artificial feeding 1/	
	10	25
10	IP: N¢ 1,467,200	IP: N¢ 3,668,000
	OP: N¢ 73,360	OP: N¢ 183,400
	NRC: N¢ 110,040	NRC: N¢ 275,100
30	IP: N¢ 4,401,600	IP: N¢ 11,004,000
	OP: N¢ 220,080	OP: N¢ 550,200
	NRC: N¢ 330,120	NRC: N¢ 825,300

N¢ 1.00 = US $0.87

Methods of Rehabilitation:

IP = hospital in-patient, N¢ 40 per day

OP = hospital out-patient, N¢ 2 per visit

NRC = nutrition rehabilitation center, in-patient, N¢ 3 per day

1/ Assuming 1976 incidence of malnutrition among children under five years old is 36,680 cases (2% of vulnerable population).

TABLE 46: Length of Postpartum Amenorrhea Among Rural Kwahu Women in Ghana

Postpartum amenorrhea (months)	N	%	Cumulative percentage
< 5	13	9	9
5-6	6	4	13
7-9	23	15	28
10-11	2	1	29
12-17	56	37	66
18-23	32	21	87
≥ 24	19	13	100
Total	151	100	

Source: Bleek, 1976

ported that 60% of women disapproved of the idea of family planning.

It is under these kinds of circumstances that the contraceptive effect of breastfeeding, reviewed on page 9 , takes on critical importance. There appears to be a widespread awareness among Ghanaian women that small time spaces between children are bad for children's health (Kaye, 1960). Bleek (1976) found that both men and women in a rural area felt that a mean of about 3 years was an ideal space between births, although the achieved space was a mean of 28 months (similar to the 30 months' space found in Danfa (Nicholaus 1977)). While there are taboos against sexual intercourse during lactation in many parts of Ghana (e.g., Goody, 1967), and some women do prolong breastfeeding intentionally to delay conception (Kaye, 1960), Bleek (1976) found actual spacing to be largely the adventitious result of the fertility-reducing effect of prolonged breastfeeding. While postpartum amenorrhea lasted for a mean of 14.6 months, postpartum abstinence was maintained for a mean of only about 6 months (although the image projected in public was that abstinence was much longer than this).

Evidence for the effectiveness of breastfeeding in reducing fertility in Ghana is emerging from the Danfa Comprehensive Rural Health and Family Planning Project. Among women who use oral contraceptives, the "failure rate", that is, the proportion who become pregnant within 12 months postpartum, is 10%. But the failure rate when no modern contraceptive is used is approximately the same (Nicholaus, 1977). Thus the failure rate for breastfeeding is at least as low as that for oral contraceptive use in this rural population.

Knodel (1977) estimates that during a 25-year reproductive period, a woman who artificially feeds and does not practice modern contraception will bear an average of 12.88 children. He estimates that if breastfeeding leads to a median of 10.6 months of amenorrhea, women will bear only 9.46 children, and with 17.7 months of amenorrhea, 7.77 children.* Data in Table 46 from rural women in Ghana suggest that the median length of amenorrhea is about 12 months.** Assuming that this holds for all Ghanaian women, and interpolating from Knodel's data, this would mean that if Ghanaian women who did not practice contraception switched from breast to artificial feeding, all else being equal, the number of children born per woman would go from 9.13 to 12.88, a 41% increase in fertility.

Clearly in Ghana, as in many other countries breastfeeding contributes very substantially to a reduction in fertility, and is likely to be having more effect on child spacing than are all artificial methods of birth control combined. Therefore, in considering the economic and other consequences of a decline in breastfeeding, important note needs to be taken of this phenomenon.

IV. DISCUSSION

A study with the goal of estimating the incremental benefits of breastfeeding over artificial feefing might from the outset be expected to be biased in favor of breastfeeding. Therefore, during the course of the analyses

*Assuming a "medium" impact of feeding practices on mortality.

**An interpolation of the data in Table 46 would yield a slightly higher figure than 12 months. However, it is likely that most of the 56 mothers in the 12-17 month category gave "one year" as the time when menstruation resumed postpartum.

conservative assumptions were made in every case possible, i.e., assumptions that were more likely to err in favor of artificial feeding. Some of the major instances include the following:

(1) All calories needed to produce breast milk were assumed to come from additions to the lactating mother's diet. Metabolic efficiency was assumed to remain constant (though it may increase) (E. F. P. Jelliffe, 1976; Naismith, 1976), as was the mother's level of physical activity (in fact, reduced levels of activity may save calories which in turn may be used for breast milk production).

(2) Breast milk and artificial infant food were assumed to be nutritionally equivalent, calorie for calorie, which undervalues the breast milk. In particular, the calories from butterfat in the powdered full cream milk used in Alternative B would not be fully absorbed.

(3) The cost of foutou was taken as a mean of a wide range of prices from many urban markets. This overestimates what the average family pays because they preferentially buy when prices are low and probably bargain better than investigators who gather prices. In rural areas staple food prices are probably lower, and of course many families grow much or all of their own food for little or no cash outlay. Artificial infant feeding on the other hand, requires ongoing cash expenditures and the Abidjan prices which were used probably underestimate rural prices (which would include additional costs for transportation and handling).

(4) The goods costs of artificial feeding included the purchase of only a minimal quantity of equipment for the cleaning and sterilization of utensils and the storage and feeding of artificial infant foods. In fact, before artificial infant feeding could be safely practiced by the vast majority of mothers in Ghana and the Ivory Coast, substantial outlays of private capital would be needed to upgrade home equipment and facilities and heavy public expenditures would be required to improve water and fuel supplies.

(5) Calculations were based on only the first two years of infant feeding. In some areas this leads to a significant underestimate of the value of breastfeeding because it continues well beyond two years. For example, estimates made by Davey (1961a) suggest that in northern Ghana only about half of the mothers had fully weaned their infants by two years of age (and data in Table 38 suggest that breastfeeding has not declined in rural Ghana since then).

(6) The opportunity cost of breastfeeding in Ghana and the Ivory Coast is in practice much lower than that implied by the figures reported in the present report. Most household and "productive" labor is relatively compatible with breastfeeding. For the minority of women whose work is not, both countries have laws which provide for paid maternal leaves during the early months when exclusive breastfeeding requires the mother to be with the infant continually, as well as two half-hour nursing breaks per working day thereafter (Greenstreet, 1971; Ministere de la Condition Feminine, 1975).

(7) It was necessary to base individual level calculations on the assumption that artificial infant feeding is successfully practiced, that is, that it does not result in gross infection or malnutrition. In fact,

there is no evidence that artificial infant feeding can be practiced safely and successfully under the conditions which exist for most Third World families. If it could, the time and goods costs would probably be greater than the estimates made. For example, a mother with one feeding bottle who gathered wood for fuel would have to devote nearly full time to bottle feeding if she were to sterilize the bottle and use cooled boiled water to mix with the milk powder.

(8) It was not possible to include costs for those factors which are probably the most important: the increased disease and fertility which often accompany the switch from breastfeeding to artificial feeding.

The factors involved in the incremental benefits of breastfeeding over artificial feeding are incorporated in a simplified model. Although each term in the equation represents some aspect of infant feeding which has obvious economic impact, both at the individual and national levels, this is difficult or impossible to quantify in most cases.

For the Ivory Coast estimates of the goods costs of breastfeeding and artificial feeding were compared at the individual or family level. The goods costs of breastfeeding were calculated based on the entire quantity of food required to produce breast milk for two years. Estimates of breast milk production were based on an extensive review of the literature. Costs for additional supplements of food for the lactating mother were based on prices obtained for commonly eaten foods, foutou with peanut sauce as one alternative, and rice with peanut sauce as the other. The goods cost of artificial feeding was based on three costs. The first was for artificial infant food in quantities calorically equivalent to the specified quantities of breast milk. One alternative (A) utilized infant formula over the entire two-year period. The second alternative (B) substituted full cream powdered milk, the least expensive type of milk suitable for infant feeding, after four months of formula feeding. The second cost was for a minimal quantity of necessary equipment and the third was for enough fuel, charcoal, to last for one hour per day for boiling water for feeds and for sterilizing bottles.

The average daily additional goods costs of artificial feeding over breastfeeding for each mother-infant couple for the entire two-year period would range from US $0.28 to $0.46. These figures can be put in perspective by comparing them with the earnings of an agricultural worker in a coffee, cocoa, cotton or rice plantation. In 1977 his/her daily wage was about US $1.00 (USDA, 1977).

For Ghana it was not possible to calculate goods costs because reliable comparative prices for artificial infant food and staple foods could not be obtained due to the problematic economic situation at the time of the study. Therefore, the goods costs calculations for Ghana were based on the estimates made for the Ivory Coast.

For time costs, this process was reversed and calculations made for Ghana were applied to the Ivory Coast. Estimates of the time required for feeding at the breast and feeding with a bottle were based on an infant feeding time study carried out on small samples of urban and rural mothers. Estimates were also made for the time required for various other activities associated with infant feeding, including obtaining goods inputs, preparation of feeds, washing and sterilization of utensils, education in feeding techniques, and additional home health care occasioned by the use of each feeding

method. While these data cannot be considered representative, they can be used to illustrate roughly some relationships which are likely to hold. For example, while artificial feeding may allow the mother herself to spend less time in infant feeding, it probably requires a far greater overall input of time if it is to be at all adequate nutritionally and hygienically. As a second example, while urban mothers may spend somewhat more time on breastfeeding, perhaps less time is required to practice artificial feeding satisfactorily in an urban setting.

The value of each family member's time was estimated according to typical wage rates for southern Ghana. This was used to calculate the total "value" of the extra time used in artificial feeding compared to breastfeeding, about US $0.50 per day. However, this should be viewed only as an exercise in gaining some further perspective on the economic relationships involved. The figures themselves do not reflect real life costs for many reasons. Each hour of infant feeding does not replace one hour of wage earning for anyone. For some few women infant feeding may be one of many aspects of child care and household work which lead them to forego wage-earning jobs altogether. In contrast, for many women in Ghana and the Ivory Coast, including many agricultural workers and market traders, time spent on breastfeeding, at least, does not interfere at all with income earning activities.

The malnutrition, disease, and death which can result from inadequate or unhygienic artificial feeding are costly in terms of human suffering as well as goods and time inputs for the family. These are not possible to quantify. It does however seem clear that when artificial feeding is practiced by families whose financial and/or time resources are already inadequate, high disease costs could hardly be avoided.

For both Ghana and the Ivory Coast, data on goods and time costs at the individual level were fitted into the model. This led to the conclusion that for one family the incremental value of two years of breastfeeding over that of artificial feeding would be between about US $600 and $700 plus any additional disease costs incurred by artificial feeding. It should be stressed on the one hand that these figures are extremely rough estimates, and on the other hand that in reality the disease costs of artificial feeding probably account for a great deal more of the incremental value of breastfeeding than goods and time costs combined.

For planning purposes it would be useful if these calculations could be extended to the national level. However, the conceptual and methodological problems multiply at this level. Furthermore, data which were inadequate for individual level calculations can hardly be expected to provide reliable estimates when extrapolated to the national level. Therefore, it was not possible to make calculations adequate enough to be applied to the model. Most of the national level calculations which were hazarded had as their main purpose to illustrate simple analytical methods which might be used to overcome various methodological problems and to achieve rough estimates from inadequate data. For each country calculations were made involving the goods costs of infant feeding at the national level, and for the cost of rehabilitating malnourished children.

One goods cost calculation for the Ivory Coast attempted to explore the economic implications of an increase in the prevalence of extended breastfeeding. This might be seen as the goods cost portion of the potential benefits that could accrue from a successful national effort to

promote breastfeeding. It illustrates that even in a country where the incidence of breastfeeding is very high, if every infant were breast fed for two years, the annual savings would be substantial, between US $16 million and $28 million, corresponding to 33 and 60 percent respectively of the Ivory Coast health budget for 1976.* About 75% of this savings results from an increase in second year breastfeeding. This probably overestimates the savings, assuming that the proportion of infants breast fed beyond one year is higher for the rest of the country than for Abidjan. Nevertheless, these figures demonstrate the potential economic importance of second-year breast feeding, in particular. They can be compared to Rohde's (1974) estimate that the economic value of second year breast milk in Indonesia was equal to US $62 million, 80 percent of the 1972-73 health budget.

In another calculation, the potential goods cost that could result from a decline in breastfeeding in the Ivory Coast was estimated. If data had been available to show that there was a decline, this calculation could have been based on figures projected into the future. Lacking this, data were used for Paris in 1955, perhaps a reasonable model for possible future changes which could occur in Abidjan. The results suggest that that if a developing country like the Ivory Coast were to become comparable in its infant feeding practices to a developed country like France, the cost would be high, ranging from US $33 million to $55 million, corresponding to 71 and 116 percent of the annual health budget for the Ivory Coast.

The method used for both calculations was to estimate the extra goods cost of artificial feeding over breastfeeding at the individual level, and then to multiply this times the populations involved. Technically, the findings do not represent true social costs. On the one hand, some costs are included which are private, but not social costs. For example, a portion of the costs merely represent money which changes hands within the country and perhaps provides employment. For the Ivory Coast this could include all costs of imported items above the c.i.f. costs for importing them, as well as the cost of extra charcoal and firewood purchased for fuel. On the other hand, the findings exclude some costs which would have to be borne by society rather than by individuals, for example, training mothers and substitute caretakers to practice artificial feeding properly and hygienically.**

Perhaps then, the results of these calculations should rather be thought of as the sum of costs at the individual level. This may have little meaning in an industrialized society, but in a society where families' discretionary funds are very limited, such figures can be thought of as proxy measures of substantial social costs. For poor families, money spent for artificial infant feeding would otherwise be spent largely for more food for the entire family. Thus the substitution of relatively high cost artificial infant food for low cost staples may result in a reduction of overall

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*The health budget for the year 1976 was 11,360.7 million FCFA, or US $46.9 million (Ministere du Budget, 1977).

**This is an extremely expensive and important cost which must not be ignored. In many countries nurses or "representatives" from commercial infant food companies are depended upon to perform this function. They, of course, are hired by the companies with the expectation that they will increase sales, and thus it is questionable whether they really reduce this portion of the social cost of artificial feeding.

calories available to the family. Popkin (1975) used simulations to illustrate the effects of such substitutions on family food intakes.

The calculations done for Ghana dealt only with a portion of the goods cost, imports of artificial infant food. The increased needs resulting from urbanization were calculated, assuming that rural migrants to urban areas immediately adopt urban infant feeding patterns (data from Dovlo, 1968, suggest that in fact this process takes several years). Again, for the purpose of carrying out illustrative calculations, data from one study in each area were used as if they were representative.

As for the Ivory Coast calculations, measures of changes in duration of breastfeeding took into account not simply changes in average weaning ages, but changes throughout the two-year period. Also, differences in breast milk output throughout the two years were taken into account. The Ghana calculation used an especially sensitive measure of these changes: the two weaning curves were graphed, and the area between them was cut out and weighed on an analytical balance.

The results showed that changing breastfeeding patterns due to urbanization would lead to an increased demand for infant formula of about 40 metric tons for 1976, at a c.i.f. cost of about US $150,000. This would amount to a 22% increase over the 225 MT actually imported in 1976.

This represents a substantial expenditure for a country with limited foreign exchange. However, it is small compared to the potential increase in use of infant formula that might occur if the current restriction in availability of infant formula were lifted. If this led to the substitution of even 1% of the potential national annual breast milk production, about 250 metric tons of additional infant formula would be required, an increase of over 100%.

Existing data suggest that malnutrition in Ghana is very prevalent. A review of the few studies which have reported relevant data suggests that only a small proportion of this malnutrition can be attributed to artificial infant feeding. Perhaps this should come as no surprise in a country where the practice of breastfeeding is still predominant, even in urban areas.

The cost of rehabilitating malnourished children was calculated in several ways, based on assumptions about the type of facility used, the duration of rehabilitation, and the percentage of malnutrition due to artificial feeding. The estimated costs ranged from US $64,000 to $9,600,000 annually. It must be stressed that this represents a small portion of the costs to society, and totally leaves out the cost to the individual sufferer and his/her family. Also, it would be much higher if artificial infant feeding in Ghana were to spread more widely through rural areas or among the urban poor.

Breastfeeding as practiced in Ghana may have a very powerful fertility-reducing effect. Data from Bleek (1976) show that postpartum amenorrhea in one rural area averages about 12 months. If these women switched entirely from breastfeeding to artificial feeding without practicing other contraceptive methods, calculations based on figures provided by Knodel (1977) suggest that the number of children born per mother would increase by about 40%.

The conclusions which could be drawn from the present study are rather limited because it was based almost entirely on preexisting data. If the analysis of the economic value of breastfeeding is to be extended to other countries, decisions must be made on the desired validity and reliability of the findings, which in turn will dictate the minimum quality and quantity of data required. The following discussion reviews some of the issues that must be taken into consideration.

To estimate goods costs, the best source of data is actual household expenditures by representative samples of families for food and for inputs for artificial feeding. Lacking this, prices for these commodities must be gathered. In either case, geographical and seasonal differences, as well as inflation must be accounted for. Even if mothers do not appear to consume the necessary quantities of food, or infants the necessary quantities of artificial infant food, calculations should be based on the costs if they did so (or account for the consequences of not doing so). Adequate quantities and quality of goods needed for breast and artificial feeding are discussed on pages 15-25.

In order to extend goods cost calculations from the individual to the national level, much additional data are required. At a minimum, a number of well designed infant feeding studies on large probability samples should be available, covering wide spans of time and geography. Optimally, if trends are to be established, studies should be longitudinal. To the extent possible, data should include length of exclusive breastfeeding, age of cessation of breastfeeding, and extent of artificial feeding. The extent to which various types of milk products are used to substitute for breast milk should be documented as carefully as possible. This should be complemented with statistics on the availability of various milk products, including if possible, amounts produced, processed, imported or exported, and sold at the wholesale level.

The issue of time costs is very complex and requires more basic research before valid estimates can be made in most countries. The time used for breastfeeding and the extent to which this time displaces other activities associated with artificial feeding must be measured, as well as whose time it is and what activities are displaced. Further research is needed to determine the minimal time (and other resources) needed to ensure that artificial infant feeding is carried out satisfactorily from nutritional and hygienic standpoints, and how this varies according to location and socioeconomic conditions.

The social cost of the time required for infant feeding could be estimated only if a number of factors were taken into consideration, including the following: (1) the extent to which breastfeeding truly restricts mothers from carrying out other economically productive activities, (2) the relative value to society of the time of others which is substituted for the mother's time if artificial feeding is practiced (e.g., if young girls thereby lose the opportunity to attend school), or the cost of providing day care, creches at the place of employment, etc., (3) the cost of time (and other inputs) necessary to educate the mother as well as substitute caretakers in methods of safe and adequate artificial feeding, and (4) the extent to which substitute caretakers are able satisfactorily to feed the infant in the mother's absence.

A great deal of expensive research would have to be carried out before any reliable estimate could be made of the costs of disease associated with each method of infant feeding. Firstly, it would be difficult to isolate the extent to which health differences were due solely to differences in feeding method, i.e., to control for all other factors. Although a longitudinal field study would be the best way to obtain the necessary data, many methodological and ethical problems would be involved.

Secondly, methods of calculating the costs of malnutrition are still at rudimentary stages, at the individual (Selowsky and Taylor, 1973), family (Cook, 1968 and 1971), and national levels (Popkin, 1972). Thirdly, it can be argued that most past attempts to cost out malnutrition are based on many faulty assumptions (Hakim and Solimano, 1976). Further attempts to improve the necessary data base and methodology simply may not be worth the high input of resources that will be required (Call and Longhurst, 1972).

To completely document the birth spacing effect of breastfeeding requires a longitudinal study. Each woman in a representative sample should be followed carefully, noting periods of contraceptive use (including type of contraceptive and method of use), pregnancy, exclusive breastfeeding, partial breastfeeding, and sexual abstinence, as well as monitoring her nutritional status. It would perhaps be equally as difficult to place a monetary value on the fertility-reducing effect of breastfeeding as on its health-producing effect.

Perhaps two major arguments could be made for carrying further the study of the economic value of breastfeeding. The first would be to increase our understanding of the reasons for changes in infant feeding patterns, and the second would be to show the economic impact of such changes, both for families and nations. The first purpose could be served only if two assumptions hold. The first is that mothers base infant feeding decisions on economic criteria and the second is that the variables involved can be measured. So little research has been done on this issue so far that it is difficult to say whether these assumptions do hold. It would appear doubtful that further in depth study of the economics of breastfeeding could provide insight into the reasons for changing infant feeding patterns that would be of sufficient practical value to justify the large expenses that would be required.

The second purpose, that of documenting the economic impact of changes in infant feeding patterns, assumes that at least the major portion of this impact can be measured. In fact, it would appear that it is very difficult to measure the impact of infant feeding on fertility and especially on health, and these in turn cannot be quantified economically. Therefore, attempts to quantify the economic impact of changes in infant feeding patterns are at best incomplete, and potentially misleading. Nevertheless, in the Third World, until the conditions exist which allowed artificial infant feeding to become relatively successful in industrialized countries, i.e., universal education and a high economic standard of living, the cost of substituting artificial feeding for breastfeeding will be extremely high. Economic arguments will continue to be used to convince politicians and bureaucrats of the importance of breastfeeding, and it would seem that modestly expensive research for such purposes would be justified.

However, once the importance of breastfeeding has achieved recognition, other avenues of research deserve higher priority. Few countries

have data on infant feeding for a representative national sample. Once such information is available, changes could be monitored by carrying out smaller studies and observing changes in the availability of artificial infant foods.

It has been argued that countries could be spurred to obtain such data if human milk were placed on food balance sheets. Maintaining a national balance sheet showing annual breast milk production and possibly "losses" would be relatively simple and accurate compared to efforts required to monitor availability of other food commodities. It is perhaps the only food commodity for which production equals consumption, i.e., there are no "post harvest losses" or "plate waste."

It is possible that some women may resent the placing of breast milk on food balance sheets, feeling that they were thereby being treated like cattle. However, many women now view breastfeeding as well as other aspects of womanhood with pride. Placing breast milk on food balance sheets might thus be viewed as a positive recognition of one of women's unique contributions to society.

Effort should be made to ensure that placing breast milk on food balance sheets would enhance rather than reduce its perceived value. For example, although a reduction in breastfeeding might result in an impressive number of liters of breast milk lost at the national level, it would look insignificant in the usual tables of per capita daily availability. (This could be solved by including in the case of breast milk, only the population concerned, say, infants under two years of age.) In any case, some method of establishing infant feeding patterns and monitoring how they change is necessary for deciding when and where intervention is needed, and the form it should take.

Fruitful avenues for further research and action may be suggested by the situation in Ghana, where at least three factors have contributed to the maintenance of high levels of breastfeeding: (1) the adventitious restriction in the availability of infant formula, (2) a national effort to protect and maintain national resources and customs and to pursue a self-reliant course of development, and (3) a relatively widespread appreciation of the value of breastfeeding on the part of many health professionals. This has occurred in spite of the presence of many other factors to which a decline in breastfeeding is often attributed: relatively rapid urbanization, high and increasing participation by women in the labor force, and widespread improvements in the standard of living.

The very effort to quantify or calculate the value of breastfeeding might justifiably be viewed with some degree of misapprehension. The overwhelming issue is one of human health versus human suffering. The high toll of death and disease which has followed in the wake of the switch from breastfeeding to artificial feeding in numerous developing countries would seem to be reason enough to make every possible effort to prevent its further spread.

Appendix I. Calculations of cost of extra food for lactating mothers in the Ivory Coast

The following calculations show the methodology used to determine the cost of a supplement to the lactating mother's diet. The supplement was composed of either foutou and peanut sauce or rice and peanut sauce. Since the number of kilocalories (kcal) needed for lactation is known, the solution is given in terms of cost per 100 kcal.

Food prices: Mean for markets in Abengourou, Bouake and Korhogo for 1976.

Food item	Price FCFA*/kg
Yam	48
Rice	100
Peanuts	128
Dried peppers	382
Tomatoes	96
Meat	342

*US $1 = FCFA 242
Source: Ministere du Plan (1977)

Foutou

Calculations are based on yam foutou. The yam is boiled in pieces and then pounded to a paste.

Yam[1] per 100 gm
Kcal: 71
Protein: 1.5
Fat: 0.1
Carbohydrate: 16.4

Foutou[2] per 100 gm
Kcal: 105
Protein: 2.2
Fat: 0.2
Carbohydrate: 23

If yam above is made into foutou, the composition per 105 kcal (100 gm of foutou) is:
Protein: 2.1
Fat: 0.1
Carbohydrate: 23.1

Thus these calculated values for protein, fat and carbohydrate in foutou agree well with the values found from actual chemical analysis.

Foutou per 100 kcal — Weight: 141 gm
Protein: 2.1 gm
Cost: 6.8 FCFA/$0.028

Rice

Cooked rice[3] per 100 gm — Kcal: 109
Protein: 2.0 gm
Fat: .1 gm
Carbohydrate: 24.2 gm

Cooked rice per 100 kcal — Weight: 92 gm
Protein: 1.8 gm

Uncooked rice[4] per 100 gm — Kcal: 363

Uncooked rice per 100 kcal — Weight: 28 gm
Cost: 2.8 FCFA

Cooked rice per 100 kcal -	Weight: 92 gm Protein: 1.8 gm Cost: 2.8 FCFA/$0.012

Peanut sauce ingredients (excluding water) according to recipe by Burnier (1972)

Ingredient	Weight (gm)	Kcal	Protein (gm)	Fat (gm)	Carbohydrate (gm)	Cost FCFA
Peanuts[5]	200	1190	46.4	101.8	43.4	25.6
Dry Peppers[6]	5	17	.7	.7	2.7	1.9
Tomatoes[7]	50	11	.5	.1	2.4	4.8
Meat[2]	400	436	78.8	8.4	--	136.8
Total	655	1654 (1749)[8]	126.4	111.0	48.5	169.1

The peanut sauce ingredients (excluding water) contain 1749 ÷ 6.55 = 267 kcal per 100 gm. The next step is to determine the amount of water to be added to these ingredients to make a sauce of the right caloric concentration.

Lauber (1977) gives the following analysis per 100 gm of peanut sauce (water included):

Protein: 9.0 gm
Fat: 6.4 gm
Carbohydrate: 2.0 gm

This yields 105 kcal per 100 gm.

In order to reach the same caloric density as Lauber, Burnier's recipe must be diluted with water such that solids represent only 105 ÷ 267 X 100 = 39 percent of the ingredients. For every 39 grams of solids used in the peanut sauce, 61 gm of water would be added. In Burnier's recipe, 655 gm of solids would require 655 ÷ 39 X 61 = 1024 gm of water.

Combining data from Burnier and Lauber, the new recipe for peanut sauce would be as follows:

	Weight (gm)	Kcal	Protein (gm)	Fat (gm)	Carbohydrate (gm)	Cost FCFA
Solid Ingredients	655	1654	126.4	111.0	48.5	169.1
Water	1024	--	--	--	--	--
Total	1679	1654	126.4	111.0	48.5	169.1

This peanut sauce would contain, per 100 gm:

kcal: 99 $(105)^8$

Protein: 7.5 gm

Fat: 6.6 gm

Carbohydrate: 2.9 gm

The amounts of protein, fat and carbohydrate in this peanut sauce agree well with those reported by Lauber (1977).

Peanut sauce, per 100 kcal -	Weight: 102 gm Protein: 7.6 gm Cost: 10 FCFA/$0.041

The ratio of foutou to sauce is 4.2 to 1 (see page 46). Thus a 100 kcal portion of foutou plus sauce with x gm sauce (99 kcal/100 gm) will have 4.2x gm foutou (105 kcal/100 gm).

$$x \text{ gm} \cdot \frac{99 \text{ kcal}}{100 \text{ gm}} + 4.2x \text{ gm} \cdot \frac{105 \text{ kcal}}{100 \text{ gm}} = 100 \text{ kcal, and } x = 19 \text{ gm}$$

Thus, 19 gm of peanut sauce + 4.2 · 19 = 80 gm of foutou will yield 100 kcal.

Foutou and Peanut Sauce, 100 kcal

	Weight (gm)	Kcal	Protein (gm)	Cost FCFA
Foutou	80	84	1.8	5.7
Peanut Sauce	19	19	1.4	1.9
Total	99	103	3.2	7.6

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Foutou and peanut sauce per 100 kcal -	Weight: 99 Protein: 3.2 Cost: 7.6 FCFA/$0.031

The ratio of rice to sauce is assumed to be the same as the ratio of foutou to sauce, that is 4.2 to 1. Thus a 100 kcal portion of rice plus sauce with x gm sauce (99 kcal/100 gm) will have 4.2x gm rice (109 kcal/100 gm).

$$x \text{ gm} \cdot \frac{99 \text{ kcal}}{100 \text{ gm}} + 4.2x \text{ gm} \cdot \frac{109 \text{ kcal}}{100 \text{ gm}} = 100 \text{ kcal, and } x = 18 \text{ gm}$$

Thus, 18 gm of peanut sauce + 4.2 · 18 = 76 gm of rice will yield 100 kcal.

Rice and Peanut Sauce, 100 kcal

	Weight (gm)	Kcal	Protein (gm)	Cost FCFA
Rice	76	83	1.5	2.1
Peanut sauce	18	18	1.4	1.8
Total	94	101	2.9	3.9

Rice and peanut sauce per 100 kcal -	Weight: 94 gm Protein: 2.9 gm Cost: 3.9 FCFA/$0.016

FOOTNOTES

[3,4]Amounts of calories, protein, fat and carbohydrate per 100 gm, according to Watts and Merrill (1963), items #1878 and #1877 respectively.

[5,6,7]Amounts of calories, protein, fat and carbohydrate per 100 gm, according to FAO/USDHEW (1968), for items #328, #748 and #825 respectively.

[2]Amounts of protein, fat and carbohydrate per 100 gm, according to analysis by Lauber (1977). Calories were calculated by using a conversion factor of 4.1 kcal/gm for protein and carbohydrate and 9.3 kcal/gm for fat (Abramson, 1971).

[8]To be comparable to Lauber's figures, the number of calories were calculated using the conversion factors mentioned in footnote 2.

[1]Amounts of calories, protein, fat and carbohydrate per 100 gm, according to FAO/USDHEW (1968), for item #262.

Appendix II. Studies of Hospital Records from the Pediatric Ward, Bouake Hospital, Ivory Coast

An analysis of hospital records from the pediatric ward at Bouake hospital in the Ivory Coast was undertaken. Record data were copied for the following six months: March, April, July, August, November and December 1976, covering 823 admissions or 49 percent of all admissions (1664) for the one-year period March 1976 through February 1977.

Twenty percent of the admissions had more than one diagnosis. Children with a diagnosis of malnutrition, including PCM, kwashiorkor and marasmus, were responsible for 62 percent of the multiple diagnoses, gastroenteritis and measles being the most common additional diagnoses.

While only 14 percent of the admissions (11 percent of diagnoses) were diagnosed as malnourished, 38 percent of the other children were found to have a weight for age less than 75 percent of the Harvard Standard (second degree malnutrition according to Gomez classification).

The results were compared with those from a similar study undertaken at the same hospital in 1974 by Jean-Louis Ledecq. There was no change from 1974 to 1976 in the percent of children with a diagnosis of malnutrition (16 and 14 percent respectively). However, the percent of children without a diagnosis of malnutrition, but with a weight for age of less than 70 percent of the Harvard Standard, had increased from 18 to 28 percent.

Hospital Records, Bouake Hospital, 1977

Month of admission	No.	%
March	209	25
April	205	25
July	105	13
August	103	13
November	91	11
December	110	13
	823	100

Age at admission (months)	Admissions No.	%
Less than 1	83	10
1 - 12	239	29
12 - 24	194	24
24 - 36	87	11
36 - 48	37	5
48 - 60	29	4
More than 60	144	18
	813	100
Age not recorded	10	

Sex	No.	%
Male	461	56
Female	361	44
Not recorded	1	-
	823	100

No. of diagnoses	No.	%
1	649	80
2	141	17
3	21	3
4	2	-
	813	100
No diagnosis recorded	10	

Diagnosis	No.		%	
PCM	61		6	
Kwashiorkor	14		1	
Marasmus	40		4	
Malnutrition		115		11
Gastroenteritis	125		12	
Measles	144		14	
Bronchitis etc.	101		10	
Other	517		52	
	1002		100	

Diagnosis	% in each category with additional diagnosis of malnutrition
Gastroenteritis	18
Measles	18
Bronchitis etc.	11
Other	8

Age at admission (months)	Mal-nutrition %	Gastro-enteritis* %	Measles* %	Bronchitis* etc. %	Other* %
Less than 1	0	2	0	2	16
1 - 12	18	54	32	49	25
12 - 24	56	32	39	24	14
24 - 36	20	4	9	7	11
36 - 48	4	2	9	2	5
48 - 60	3	3	3	3	4
More than 60	-	4	9	12	26
	100	100	100	100	100

*Excluding cases with diagnosis of malnutrition.

Age at admission (months)	Deaths	
	No.	%
Less than 1	23	28
1 - 12	24	29
12 - 24	12	15
24 - 36	9	11
36 - 48	2	2
48 - 60	5	6
More than 60	8	10
	83	100

Of all admissions 10% died.

Children 0-5 years old

Diagnosis*	Less than 75% of standard weight for age %
Gastroenteritis	45
Measles	36
Bronchitis etc.	31
Other	41
All	38

*Cases with additional diagnosis of malnutrition were excluded.

Diagnosis	Mean % standard weight for age
Malnutrition	62
Gastroenteritis, excluding malnutrition	77
Measles, excluding malnutrition	78
Bronchitis etc., excluding malnutrition	82
Other, excluding malnutrition	79
All excluding malnutrition	79
All including malnutrition	76

A Comparison of Two Studies of Bouake Hospital Records--
Carried out 1974 and 1977 respectively

Age of admission (months)	1974 %	1977 %
0 - 6	20	23
6 - 12	24	16
12 - 24	26	24
24 - 72	20	22
72 and above	11	15
	100	100

Ages of children who died (months)	1974 %	1977 %
0 - 6	31	42
6 - 12	23	15
12 - 24	23	14
24 - 72	18	19
72 and above	3	10
	100	100

Ages of children with diagnosis of malnutrition (months)	1974 %		1977 %	
0 - 6	5		5	
6 - 12	26		13	
12 - 18	25	53	43	56
18 - 24	28		13	
24 - 72	17		26	
	100		100	

Miscellaneous	1974	1977
Percent female	44	44
Percent male	56	56
Percent of admissions who died	11	10
Percent of deaths with diagnosis of malnutrition	25	17
Percent of children with diagnosis of malnutrition	16	14
Percent of children without diagnosis of malnutrition but with % standard weight for age less than 70	18	28

Appendix III. Time Required for Solid Feeding

For the purposes of this report, it is assumed that the feeding of solid foods is equally necessary at equal ages for both breast and artificial feeding. Therefore, the cost of solid feeding is not calculated.

However, the time required to feed solid foods to infants is generally very substantial, and this has a number of important implications. Table 33 shows that, for 9 infants in Accra, solid feeding required 28.2 minutes per day. This is about the same amount of time as was required for artificial milk feeding, somewhat less than for breastfeeding. However, the mean age of these infants is 8.3 months, and the youngest is four months old. Spoon feeding solid foods to an infant requires much more time (and patience) at younger ages.

The washing and preparation time for solid feeding is so high, however, that it is by far the most time-consuming infant feeding practice overall. This is because solid feeds were prepared separately for the infant, and usually consisted of a porridge requiring a number of steps in cooking and processing.

The greater time input necessary for solid feeding compared with breastfeeding may be a major reason that mothers delay supplementation of their infants. Poverty often can be characterized not only by a lack of food of adequate quality and quantity, of water, fuel, housing, and medical care, but also a lack of time and energy (Gordon, 1973b). Recommending to an impoverished mother that she spend a great deal of time that she does not have to spare in preparing and feeding supplemental food to her four-month-old infant is likely to be as ineffective as recommending she spend money she cannot spare on a more convenient commercial infant food.

Hofvander (1977) relates that in Tanzania mothers were advised to prepare multimixes for their children. As an experiment, a number of nursing students were asked to follow a mother and participate in all her daily activities, fetching water and firewood, washing, cooking for the family in addition to

preparing the multimixes. After a couple of days, the nursing students returned, exhausted, and said that if they were to follow these mothers' schedules they would have no time or energy left for preparing multimixes.

Appendix IV. Brief Information about the Ivory Coast and Ghana

A. The Ivory Coast

The Republic of Ivory Coast became independent from France in 1960. It is situated along the Guinea Coast of West Africa and is bordered on the west by Liberia and Guinea, on the north by Mali and Upper Volta, and on the east by Ghana. The country has a total land area of about 320,000 km^2. In mid-1975 the population was about 6.7 million. With a birth rate of 46 and a death rate of 21 per thousand the country has an annual population growth of 2.5% live births (Population Reference Bureau, 1976). The infant mortality rate is about 138 per thousand (WHO, 1976). Average life expectancy at birth in the Ivory Coast is now about 44 years. Approximately 43% of the population are under 15 years of age. About 28% of the people live in urban areas (Population Reference Bureau, 1976). In addition to 356,000 wage earners there are 220,000 migrant workers in the Ivory Coast (Overseas Business Reports, 1976a).

The per capita GNP in 1973 was about U.S. $510 (Population Reference Bureau, 1976). In 1975 total exports amounted to about U.S. $1,200 million and total imports to about U.S. $1,100 million (Overseas Business Reports, 1976a). The Ivory Coast is Africa's biggest coffee producer, ranking third in the world after Brazil and Colombia. It is the world's second largest producer of cocoa after Ghana. Together with timber, coffee and cocoa accounted for about 70% of total exports in 1975 (West Africa, 1976c). The Ivory Coast is also a big exporter of bananas. Principal imports are capital equipment, semi-finished metals, transportation and construction equipment, paper products, textiles, crude petroleum and chemicals.

The key agricultural policy has involved diversification, a diversification not only of export crops, but of domestic food crops as well. Coupled with programs aimed at increasing production, this diversification has aimed at decreasing reliance on coffee as the main export crop and at achieving greater self sufficiency in rice and vegetables (May, 1968).

The Ivory Coast can be divided into three major subsistence crop areas: the North where cereals such as millet, sorghum and maize provide the majority of the calories; the East where the bulk of the diet is made up of yams, manioc and plantain; and the West where the main staple is rice (Posner, 1973).

B. Ghana

Ghana, known as the Gold Coast, under British Colonial Rule, has been independent since 1957. It is situated along the Guinea Coast of West Africa bordering Ivory Coast in the west, Upper Volta in the north, and Togo in the east. It covers an area of about 240,000 km^2.

In mid-1975 the population was about 9.9 million (Population Reference Bureau, 1976). Based on a birth rate of 49 per thousand and a death rate of 22 per thousand, the annual growth rate is estimated at 2.7%. In 1968-1969 the urban infant mortality rate was 98 per thousand live births and the rural infant mortality rate was 161 (Gaisie, 1975). Average life expectancy at birth in Ghana is about 44 years. Approximately 47% of the population are under 15 years of age. About 29% of the people live in urban areas (Population Reference Bureau, 1976).

The labor force is estimated to be 3.4 million. However, only 1.4 million are full time wage earners, while the remaining 2 million are either underemployed or unemployed. About 60% of the total labor force is engaged in agriculture (Overseas Business Reports, 1976b).

The 1973 per capita GNP was U.S. $290 (Population Reference Bureau, 1976). Total exports amounted to about U.S. $910 million and total imports to about U.S. $890 million in 1975. About 60% of the country's foreign exchange is derived from cocoa (Overseas Business Reports, 1976b). However, in the last 10 years production has been declining so that Ghana's share of the world market has dropped from 37% in 1965 to 27% in 1975 (Africa, 1976). Other exports include gold, aluminum, industrial diamonds and timber. The main imports are machinery and transportation equipment, cloth and yarn, crude petroleum, cereals, sugar, agricultural chemicals, pharmaceuticals and paper products (Overseas Business Reports, 1976b).

In 1972 an agricultural program called "Operation Feed Yourself" was launched, later followed by "Operation Help the Farmer" and "Operation Feed Your Industries". These programs aimed to increase agricultural production, especially of local food crops, as well as agricultural products for local industry. Special attention was given to increasing production of rice, maize, and cassava. The major crops grown for export are pepper, ginger, avocado, and citrus fruits (Paxton, 1975).

Ghana is divided naturally into three distinctly different geographic areas. These are the Northern savannah, the Southern forest, and the Southern savannah. Diets differ considerably among the different regions, particularly with respect to the staple foods. In the Northern savannah region the major staples are millets, sorghums and to some extent yams. In the Southern forest belt tubers such as cassava, yams and coco yams, together with plantain, constitute the major staples. In the Southern savannah region along the coast, the basic staple is maize and to a lesser extent plantain (Sai, 1975). Very little meat and fish is eaten in the Northern savannah region. Meat is consumed more frequently in the forest region, whereas fish consumption is higher in the coastal region (Ofosu-Amaah, 1968).

Abramson, E. (1971) Kosttabell (Food Table). Stockholm: Lärmodedelsförlagen.

Adou, J.A., et al. (1970) Rougeole et malnutrition. Revue Medicale de Cote d'Ivoire No. 19: 5-8.

Adou, J.A. (1976) Evolution de la morbidite et de la mortalite pediatriques hospitalieres au cours des cinq dernieres annees au C.H.U. d'Abidjan de 1971 a 1975. Med. d'Afrique Noire 23: 19-24.

Adou, J.A. (1977a) Presentation at International Pediatric Association Seminar on Infectious Diseases in Children (Part 2). Baghdad. Nov. 7-8, 1975. Bull. Int. Ped. Assn. 2(1): 20.

Adou, J.A. (1977b) Personal communication.

Almroth, E.S. (1976) Breast Feeding Practices in a Rural Area in Jamaica. MNS Thesis, unpublished, Cornell University.

Almroth, S.G. (1978) Water requirements of breast-fed infants in a hot climate. Am. J. Clin. Nutr., 31: 1154-1157.

Arneil, G.C., et al. (1975) Letter to the editor on National Dried Milk. Lancet 2: 450.

Asiedu, E.R. Use of dried milks in Ghana, in Proceedings of the Seventh International Congress of Nutrition, Hamburg, 1966, Volume 3 (Nutrition under various geographic and climatic conditions). Braunschweig, 1967.

Aykroyd, W.R. (1977) Is breast feeding best for all infants, everywhere? Nutrition Today. 12: 15-18. January/February.

Baddoo, M.A. (1974) The Pattern of malnutrition in Ghana. In: Ofosu-Amaah, 1974a, pp. 65-74.

Bailey, K.V. (1965) Quantity and composition of breastmilk in some New Guinean populations. J. Trop. Ped. 11: 35-49.

Barnes, R.A. and D.A. Levitsky (1972) Nutritional and environmental interactions in the behavorial development of the rat; long-term effects. Science 176: 68-71.

Beal, V.A. (1970) Nutritional intake. In: McCammon, R.W. (ed). Human Growth and Development. Springfield, Ill.; Charles Thomas, p. 63.

Becroft, T.C. (1967) Child-rearing practices in the highlands of New Guinea: a longitudinal study of breast feeding. Med. J. Aust. 23 Sept., pp. 598-561.

Berg, A. (1973) The Nutrition Factor. Washington, D.C.: The Brookings Institution.

Blackburn, M.W. and D.H. Calloway. (1976) Energy expenditure and consumption of mature, pregnant and lactating women. J. Am. Diet. Assn. 69: 29-37.

Blankhart, D.M. (1962) Measured food intakes of young Indonesian Children. J. Trop. Ped. 8: 18-21.

Bleek, W. (1976) Spacing of children, sexual abstinence and breast feeding in rural Ghana. Soc. Sci. & Med. 10: 225-230.

Boohene, E.S. (1974) Nutrition Rehabilitation in Accra. (mimeo)

Brambell, R. (1970) The Transmission of Passive Immunity from Mother to Young. New York: American Elsevier Pub. Co. Inc.

Brooks, R.D. (1975) Cost of selected health institutions in the Central Region 1972-73. G. Med. J. 14: 209-214.

Brooks, R.D. (1977a) Eastern Region Health Institution Costs Financial Year 1974-75. First Summary Report, March 4. Corrected and amended as of 14 November, 1977.

Brooks, R.G. (1977b) Personal communication, 14 November, 1977.

Brown, J. (1970) A note on the division of labor by sex. Am. Anthropologist 72: 1073-8.

Brown, R. (1977) Relactation: an overview. Pediatrics 60: 116-120.

Buchanan, R. (1975) Breast-feeding--aid to infant health and fertility control. Pop. Reports, J., July. Washington, D.C.: Department of Medical and Public Affairs, George Washington University Medical Center.

Bullen, J.J., et al. (1972) Iron-binding proteins in milk and resistance to Escherichia coli infection in infants. Brit. Med. J. 1: 69-75.

Burnier, M. (1972) Food survey in an Ivory Coast brush village covering pre-school age children with a study of social environment. 1971-72. Nestle Foundation, Geneva.

Buss, D.B. (1975) Cost of breast-feeding. Lancet 2: 766. Oct. 18.

Butz, W. (1977) Economic Aspects of Breastfeeding. Paper for the Conference on Nutrition and Reproduction NICHHD/NIH, Bethesda, February 13-16.

Butz, W.P. and J.P. Habicht (1976) The effects of nutrition and health on fertility hypothesis, evidence and interventions. In Ridker, R.G. (ed) Population and Development, the Search for Selective Interventions. Washington, D.C.: Resources for the Future, pp. 210-238.

Caldwell, J.C. (1967) Fertility attitudes in three economically contrasting rural villages of Ghana. Econ. Dev. & Cult. Changes 15(2): 217-38.

Caldwell, J.C. (1968) Population Growth and Family Change in Africa: The new urban elite in Ghana. Australian National University Press: Canberra.

Call, D.L. and R. Longhurst (1972) Evaluation of the economic consequences of malnutrition. Proc. West. Hemi. Nutr. Conf. III: 312-317.

Cameron, M. and Y. Hofvander (1976) Manual on Feeding Infants and Young Children. 2nd edition. PAG/UN: New York.

Carlsson, B., et al. (1976) Escherichia coli antibody content in human milk from healthy Swedish mothers and mothers from a very low socio-economic group of a developing country. Acta Paed. Scand. 65: 417. Cited by Sjölin, 1976.

Census Office (1972) Population Census of Ghana, Vo. II, Statistics of Localities and Enumeration Areas. Accra.

Central Bureau of Statistics (1970) Statistical Handbook of the Republic of Ghana, 4th edition.

Central Bureau of Statistics (1976) Summary of the Economic Survey 1969-1971. Statistical Newsletter No. 26/76. 17 Aug., mimeo.

Central Bureau of Statistics (1977) Consumer Price Index Numbers: December 1976. Statistical Newsletter No. 6/77. 28 Mar., mimeo.

Chandra, R.K. (1978) Immunological aspects of human milk. Nutrition Reviews 36: 265-272.

Chavez, A., et al. (1975) Child nutrition problems during lactation in poor rural areas. Proc. 9th Congr. Nutr., Mex. 1972. Vol 2, pp. 90-105. (Karger: Basel, 1975)

Chinery-Hesse, M. (1974) Food Aid and Ghana. In: Ofoso-Amaah, 1974a, pp. 371-380.

Christian, E.C. (1967) Why do our children die? Ghana Med. J. 6(3): 111-114.

Commey, E.K. (1975) Report on the Kotobabi District Malnutrition Survey Conducted in May-Aug. 1970. Nutrition Division, Ministry of Health. Accra.

Commey, E.K. and J.K. Anang (1975) Report on Adzen Kotoku Nutrition Survey Conducted in June 1974. Accra: Applied Nutrition & Field Unit, Nutrition Division, Ministry of Health.

Cook, R. (1968) The financial cost of malnutrition in the "Commonwealth Caribbean". J. Trop. Ped. 14: 60.

Cook, R. (1971) The cost of malnutrition in Jamaica. Ecol. Fd. and Nutr. 1: 61-66.

Coombs, P.H. (1968) The World Crisis in Education: A Systems Analysis. London: Oxford U. Press. Cited by Smart, 1972.

Coulson, K.M., et al. (1977) Hematocrit levels in breast-fed American babies. Clin. Ped. 16: 649-651.

Crapuchet (1956) L'Employ du Temps de la Femme Agni.

Crawford, M.A., et al. (1977) Breastfeeding and human milk composition. Lancet 1: 99-100. (8002)

Creery, R.D.G. (1975) Cost of breast-feeding. Lancet 2: 930, Nov. 8.

Cunningham, A.S. (1977) Morbidity in breast fed and artificially fed infants. J. Ped. 90: 726-729.

Dako, D.Y. and J.D. Watson (1972) Report on the Nutritional Status of the population of Baafi conducted in August 1972. Department Nutrition and Food Science, Legon, mimeo.

Dalton, G.E. and R.N. Parker (1973) Agriculture in Southeast Ghana, Vol II. Special Studies. Development Study No. 13. Dept. of Agricultural Economics and Marketing, University of Reading (UK) cited by Fuchs-Carsch, 1975.

Dasen, P.R., et al. (1977) Early moderate malnutrition and the development of sensori-motor intelligence. J. Trop. Ped. 23: 146-157, Mono No. 50.

Davey, P.L.H. (1961a) Breast-feeding and the Nutrition of Children from Birth to Two Years of Age. Mimeo report from the National Nutrition Survey.

Davey, P.L.H. (1961b) The Nutrition of Pregnant Women. (Mimeo report from the National Nutrition Survey.)

Davey, P.L.H. (1963) A summary of conclusions and recommendations of the National Nutrition Surveys of 1961 and 1962. (Mimeo, FAO library).

deGraft-Johnson, K.T. (1974) Population growth and rural-urban immigration, with special reference to Ghana. Int'l. Labour Rev. 109-110: 471-485.

deGraft-Johnson, S. (1974) Discussion in Ofosu-Amaah, 1974a, pp. 118-119.

Deem, M.E. (1931) Observations on the milk of New Zealand women. Arch. Dis. Child. 6: 53-70.

Delahaye, P. (1977) Unpublished data on weight for age of preschool children brought to under fives clinics in the Bawku district Upper Region. Figures calculated by one of the authors (TG)

Delormas, T. (1972) Enquete sur l'Attitude du Personnel ParaMedical vis-a-vis de l'Alimentation de l'Enfant en Bas-Age dans le Milieu Urbain Africain. Abidjan: Institut National de Sante Publique.

Delormas, F., et al. (1974) Enquete d'Alimentation. Abidjan: Institut National de Sante Publique, 1974.

den Hartog, A.P. (1970) Some aspects of food habits in Pantang, a farming community in the coastal savannah of Ghana. Rome, FAO, Sept. 1970.

Department of Health and Social Security (1974) Present Day Practice in Infant Feeding. H.M. Stationery Office, London.

Devadas, R.P., et al. (1973) Nutritional Status and nutrient intake of children in the age group of 0-30 months in a rural area. Ind. J. Nutr. Diet. 10: 173.

Dovlo, F.E. (1968) A study of infant feeding practices in Accra. Food Research Inst. Bull. No. 1, Jan. pp. 32-42.

Duponchel, M. (1971) Enquete Socio-Sanitaire sur un Quartier d'Adjame. Abidjan: Ministere de la Sante Publique et de la Population. Institut National de Sante Publique.

Dutertre, J. et O. Paul (1974) Enquete de croissance enfants sains P.M.I. Deux ans six ans. Abidjan: Institut National de Sante Publique.

Dutta-Roy, D.K. (1969) The Eastern Region Household Budget Survey. Tech. Publ. Series No. 6, ISSER, Legon.

Eckholm, E.P. (1975) The other energy crisis: firewood. Worldwatch Paper No. 1.

Engmann, E.V.T. (1973) The labour force in Ghana, a statistical analysis of the distribution and interrelations of its attributes. Bull. of the Ghana Geographical Assn. 15: 50-71.

FAO (1975) In Defense of Breast Feeding. Mimeo prepared by Food Policy and Nutrition Division.

FAO (1976) Perspective Study of Agricultural Development in Ghana. Nutrition. Rome. Restricted. ESP/PS/GHA/76/15.

FAO/USDHEW (1968) Food Composition Tables for use in Africa. U.S. Dept. Health Education and Welfare, Bethesda, Md.

Fairney, A., et al. (1977) Vitamin D and human lactation. Lancet 2: 739-741. Oct. 8.

Fellowship Course in Food Sciences and Applied Nutrition (1967) Report of Nutritional Studies in Accra area, Ghana, University of Ibadan.

Flewett, T.H. (1976) "Rotovirus" detected in 60% of cases of acute gastroenteritis in young children. Proc. Royal Soc. Med. 69: 693-696.

Fomon, S.J. (1974) Infant Nutrition. Phila: W.B. Saunders.

Fomon, S.J. (1976) Preliminary results from longitudinal infant feeding study conducted at Iowa State University Medical School, presented in a seminar at Cornell University, 8 Nov.

Fomon, S.J., et al. (1971) Food consumption and growth of normal infants fed milk-based formulas. Acta Paed. Scand. (Suppl. 223).

French, J.G. (1967) Relationship of morbidity to the feeding patterns of Navajo children from birth through twenty-four months. Am. J. Clin. Nutr. 20: 375.

Fuchs-Carsch, M. (1975) Women in Ghanaian Society; An annotated bibliography prepared for USAID/Ghana; April.

Gabbud, J.P., et al. (1975) Biochemical study on the nutritional status of children in the Ivory Coast. Proc. 9th Int. Congr. Nutrition, Mexico.

Gaisie, S.K. (1973) Determinants of Population Growth in Ghana. Doctoral Thesis, Australian National University, Canberra. Cited by North, et al, 1975.

Gaisie, S.K. (1975) Levels and Patterns of infant and child mortality in Ghana. Demography 12(1): 21.

Gaisie, S.K. (1976) Estimating Ghanaian Fertility, Mortality, and Age Structure. U. of G. Pop. Studies No. 5. Population Dynamics Programme, Legon.

Gaisie, S.K. and S.B. Jones (1970) Ghana-Country Profiles. Pop. Council and Int'l Inst. for the Study of Human Reproduction, Columbia, U.

Golding, P.T.F. (1962) An enquiry into household expenditures and consumption and sale of household produce in Ghana. Econ. Bull. of Ghana VI. 4. pp. 11-33.

Goldman, A.S. (1973) Host resistance factors in human milk. J. Pediat. 82: 1082.

Goldman, A.S. (1976) In: Food and Immunology. Stockholm. (cited by Jelliffe and Jelliffe, 1976).

Gomez, V.M. (1976) "Factors which lead to protein calorie malnutrition in a selected group of children in the age group five months to five years, at the Princess Marie Louise Hospital". Dept. Home Sci. Dissertation for B. Sc., University of Ghana.

Goody, J. (1967) The Social Organization of the LoWilli. 2nd edition. Oxford U. Press, London. (first published in 1956).

Gopalan, C. (1956) Protein intake of breast-fed poor Indian infants. J. Trop. Ped. 2: 89-92.

Gordon, G.M. (1973a) An evaluation of nutrition education given to pregnant and nursing women in six communities in the Upper Region of Ghana. M. Sc. Thesis, University of Ghana, Legon.

Gordon, G. (1973b) Nutrition education in the Upper Region. A Help or a Game? The Home Scientist Vol. 2, No. 4. pp. 7-14. (Journal of the Ghana Home Science Assn.)

Gordon, G. (1976a) Evaluation of Bawku District Nutrition Program. Mimeo, October.

Gordon, G. (1976b) Drought in the Bawku District. Mimeo, 12 July, p. 8.

Grant, F.W. (1955a) The Nutrition and Health of Children in the Gold Coast published by the U. of Chicago Committee on Home Economics.

Grant, F.W. (1955b) Nutrition and health of Gold Coast Children. II. Care and Physical Status of Children. JADA 31: 694-702.

Grantham-McGregor, S. and E.M. Back (1970) Breastfeeding in Kingston, Jamaica. Arch. Dis. Child. 45: 404.

Greenstreet, M. (1971) Employment of Women in Ghana. Int'l. Labour Review 103: 117-129.

Greiner, T.H. (1977a) Regulation and education: strategies for solving the bottle feeding problem. Cornell International Nutrition Monograph Series #4.

Greiner, T.H. (1977b) Infant food advertising and malnutrition in St. Vincent. Unpublished MS Thesis, Cornell University.

Greiner, T.H. (1977c) Breastfeeding in decline: perspectives on the causes. International Planned Parenthood Federation/International Union of Nutritional Sciences Conference on Lactation, Fertility, and the Working Woman. Rockefeller Study Center, Bellagio, Italy, 5- 12 July. (Proceedings in press.)

Gronau, R. (1973a) The effect of children on the housewife's value of time. J. Poli. Econ. 81(2): 5168-199. Mar/Apr. pt 2.

Gronau, R. (1973b) The intrafamily allocation of time: the value of housewives' time. Amer. Econ Rev. 63(4): 634-651.

Grulee, C.B., et al. (1934) Breast and artificial feeding. J. Am. Med. Assn. 103: 735.

Gunther, M. (1975) The neonate's immunity gap, breastfeeding and death. Lancet 1: 441.

Gyӧrgy, P. (1971) Biochemical aspects. In: The Uniqueness of Human Milk. AJCN 24: 970.

Habicht, J.P., et al. (1975) Repercussions of lactation and nutritional status of mother and infant. Proc. 9th Int. Congr. Nutr., Mexico, 1972. Vol. 2. pp. 106-114. (Karger, Basel)

Haddad, F. L'epidemiologie du kwashiorkor a Port-Bouet, Abidjan, 1975 (travail du l'Institut Nationale de la Sante Publique, BPV 47, 1975).

Hakim, P. (1977) Programs to encourage breast feeding in developing countries. Lactation Review 2(2): 4.

Hakim, P., and G. Solimano (1976) Nutrition and National Development, establishing the connection. Food Policy, No. 3, May.

Hall, B. (1975) Changing composition of human milk and early development of an appetite control. Lacet 1: 779. Apr. 5.

Hambraeus, L. (1977) Proprietary milk versus human breast milk in infant feeding. Ped. Clin. NA 24(1): 17-36.

Hanafy, M.M., et al. (1972) Maternal nutrition and lactation performance. J. Trop. Ped. 18: 187-191.

Hansen, J.D., et al. (1971) What does nutritional growth retardation imply? Ped. 47: 299.

Hanson, L.A., et al. (1975) Immune defensive factors in human milk. Mod. Probl. Pediat. 15: 63.

Harfouche, J.K. (1970) The importance of breast-feeding. J. Trop. Ped., Sept., pp. 135-175.

Harrar, J.G. (1974) Nutrition and numbers in the Third World. Nutrition Reviews 32: 97-104.

Harrington, J.A. (1971) A comparative study of infant and childhood survivorship in West Africa. Ph.D. thesis, Cornell University.

Harris, S.G. and J.H. Highland (1977) Birthright Denied: The Risks and Benefits of Breast Feeding. 2nd edition, revised. Washington: Environmental Defense Fund.

Harrison, G.A., et al. (1975) Body composition changes during lactation in a New Guinea population. Annals of Human Biology 2: 395.

Helsing, E. (1976) Lactation education: the learning of the "obvious". Ciba Foundation Symposium 45, pages 215-224 plus discussion, pages 224-230.

Herzig, M.E., et al. (1972) Intellectual levels of school children severely malnourished during the first two years of life. Ped. 49: 814.

Heseltine, M.A., et al. (1966) Economy in nutrition and feeding of infants. Am. J. Pub. Hlth. 56: 1756-1782.

Hinderink, J. and J. Sterkenburg (1975) Anatomy of an African town. Utrecht: State Univ. of Utrecht (Holland).

Hindley, C.B., et al. (1965) Some differences in infant feeding and elimination training in five European longitudinal samples. J. Child Psychol. Psychiat. 6: 179-201.

Hofvander, Y. (1977) Comment at Första Nordiska Konferensen i Märingslära, June, Stockholm.

Idusogie, E.O. (1972) The Relation of population and nutritional health problems in African communities. Joint FAO/WHO/OAU Regional Food and Nutr. Commission for Africa. Special Paper No. 7., June.

Idusogie, E.O. (1974) Traditional customs, social and food habits related to malnutrition in Ghana. In: Ofosu-Amaah, 1974a, pp. 97-116.

Inglis, G.C., et al. (1978) Anti-Rotavirus antibody in human colostrum. Lancet 1: 559. March 11.

International Monetary Fund (1976) International Financial Statistics. January. Ghana: pp. 160-2.

Jansen, A.A.J., et al. (1960) Quantity and composition of breast milk in Biak Island (Neth. New Guinea). Trop. Geogr. Med. 2: 138-144.

Jelliffe, D.B. (1962) Culture, Social Change, and Infant Feeding; current trends in tropical regions. Am. J. Clin. Nutr. 10: 19.

Jelliffe, D.B. (1968) (2nd ed.) Infant Nutrition in the Tropics and Subtropics. Geneva, WHO Mono Series No. 29.

Jelliffe, D.B. and F.J. Bennett (1975) Aspects of child rearing in Africa. J. Afr. Studies 2(3): 363-386.

Jelliffe, D.B. and E.F.P. Jelliffe (1970) The urban avalanche and child nutrition. II. Special problems in developing countries. J. Am. Diet. Assn. 57: 114-118.

Jelliffe, D.B. and E.F.P. Jelliffe (1975a) Human milk, nutrition, and the world resource crisis. Science 188: 557-561.

Jelliffe, D.B. and E.F.P. Jelliffe (1975b) Duration of breast-feeding. Lancet 1: 752-3, Mar. 29.

Jelliffe, D.B. and E.F.P. Jelliffe (1976) Cost of breast-feeding. Lancet 1: 42, Feb. 21.

Jelliffe, D.B. and E.F.P. Jelliffe (1977) Alleged inadequacies of human milk. Clin. Ped. 16(12): 1140-1144.

Jelliffe, D.B. and E.F.P. Jelliffe (1977) "Breast is best: Modern Meanings". New England Journal of Medicine 297: 912-915.

Jelliffe, D.B. and E.F.P. Jelliffe (1978) The volume and composition of human milk in poorly nourished communities. A review. Am. J. Clin. Nutr. 31: 492-515.

Jelliffe, E.F.P. (1976) Maternal nutrition and lactation. In: Breast Feeding and the Mother. Ciba Foundation Symposium 45. pp. 119-143.

Juadiong, L.T. (1967) Food technology, handling, and hygiene. Paper 7. In: Fellowship Course in Food Science and Applied Nutrition.

Kanaaneh, H. (1972) The relationship of bottle feeding to malnutrition and gastroenteritis in a pre-industrial setting. J. Trop. Ped. 18: 302.

Kanawati, A.A. and D. McLaren (1973) Failure to thrive in Lebanon. II. An Investigation of the causes. Acta Paed Scand. 62: 571.

Kapikian, A.Z. (1977) Viral diarrhea. Paper presented at the Workshop on Effective Interventions to Reduce Infection in Malnourished Populations. Port-au-Prince, Haiti. June 12-16.

Karmarkar, M.B., et al. (1959) Studies on human lactation (Part 1). Ind. J. Med. Res. 47: 344-355.

Kassi, M. Saint-Jalm (1971) Etude de la Morbidite et Mortalite au cours de Deux Annees du Service de Pediatrie de l'hopital de Treichville. These pour le doctorat en medecine No. 18.

Kaucher, M., et al. (1946) Adequacy of the diet during lactation. J. Am. Diet. Assn. 22: 594-601.

Kaye, B. (1960) Child Training in Ghana. Institute of Education, Child Development Monograph No. 1. University of Ghana, Legon.

Knodel, J. (1977) Breast-feeding and population growth. Science 198: 1111-5.

Korchounova, E. (1978) International Labour Office, Women Workers' Questions, personal communication to the author, 9 Feb. 1978.

Kumekpor, T. (1973) Mothers and Wage Labour Employment. The Home Scientist. Vol. 2, No. 4: 16-30.

Lakdawala, D.R. and E.M. Widdowson (1977) Vitamin D in Human Milk. Lancet 1: 167, Jan. 22.

Lambrinides, G. (1977) World Food Programme Representative, Abidjan. Personal Communication.

Lamm, E., et al. (1977) Economy in the feeding of infants. Ped. Clinics of No. Am. 24: 71-84.

Larguia, A.M., et al. (1977) Fresh human colostrum for the prevention of E. coli diarrhea -- a clinical experience. J. Trop. Ped. 23: 289-290.

Larsen, S.A. and D.R. Homer (1978) Relation of breast versus bottle feeding to hospitalization for gastroenteritis in a middle-class U.S. population. J. Ped., Mar. 1978, pp. 417-418.

Latham, M.C. (1977) Introduction in Greiner, 1977a.

Latham, M.C. and F. Cobos (1971) The effects of malnutrition on intellectual development and learning. Am. J. Pub. Hlth. 61: 1307-1324.

Latham, M.C., et al. (1977) Breast Feeding. Nutrition Today 12: 33-34. July/August.

Lauber, E. (1977) Personal communication. Foundation Nestle. Adiopodoume Research Center. Abidjan, Ivory Coast.

Lawton, J.W.M. and K.F. Shortbridge (1977) Protective factors in human breast milk and colostrum. Lancet 1: 253, Jan. 29.

Ledecq, J.L. (1974) Quelques donnees a propus des hospitalisations en Pediatrie. Bouake, Ivory Coast. Unpublished.

Lillington, A.W. (1975) Inflation hits the bottle (letter). Lancet, Sept. 13, p. 512.

Lisk, F. (1976) Inflation in Ghana 1964-75: its effects on employment, incomes and industrial relations. Int'l. Labour Rev. May/June, Vol. 113: 359-375.

Lönnerdal, B., et al. (1976) Breast milk composition in Ethiopian and Swedish mothers. II. Protein content and composition. Am. J. Clin. Nutr. 29: 1134.

Lozoff, B., et al. (1977) The mother-newborn relationship: limits of adaptability. J. Ped. 91: 1-12.

Martinez, C. and A. Chavez (1971) Nutrition and development in infants of poor rural areas. I. Consumption of mother's milk by infants. Nutr. Rep. Int'l. 4: 139-149.

Medical Services (1967) Annual Report, Accra.

Mellander, O., et al. (1959) Breast feeding and artificial feeding. A clinical, serological and biochemical study in 402 infants with a survey of the literature. The Norbotten study. Acta Paed Scand. (Suppl 116) 48: 1.

Mellor, J.W. (1975) India and the New Economics of Growth. NY: Twentieth Century Fund. Cited by Popkin 1976.

Ministere de la Condition Feminine (1975) Commission Nationale de la Promotion Feminine, Sous-Commission chargee du Travail Feminine en Cote d'Ivoire. Abidjan.

Ministere du Budget (1977) Direction des Budgets et comptes, Abidjan, Ivory Coast.

Ministere du Plan (1976) La Cote d'Ivoire en Chiffres, Societe Africaine d'Edition, 1.

Ministry of Economic Planning (1977) Five Year Development Plan 1975/76-1979/80 Parts I, II, III. Accra.

Ministry of Economics and Finance (1973, 1974, 1975) Direction de la Statistique. Statistiques du commerce exteriour de la Cote d'Ivoire.

Ministry of Health (1967) Medical Statistical Report No. 1, 1967. Accra.

Ministry of Health Planning Unit (1977) Health Planning Data Book for Ghana, Accra.

Morrow, R.H. (1977) Personal communication (interview), June 29.

McKigney, J. (1968) Economic aspects of infant feeding practices in the West Indies. J. Trop. Ped. 14: 55-58.

McKigney, J. (1971a) Economic aspects. Am. J. Clin. Nutr. 24: 1005.

McKigney, J. (1971b) Cost/Value and selection of milks for use in artificial feeding. West Indian Med. J. 20: 213.

McMillan, J.A., et al. (1976) Iron sufficiency in breast-fed infants and the availability of iron from human milk. Ped. 58(5): 686-691.

NAS (National Academy of Sciences) (1974) Recommended Dietary Allowances. Washington, D.C.: NAS.

Naismith, D.S. (1976) Discussion. In: Breast Feeding and the Mother. Ciba Foundation Symposium 45. p. 138.

Nerlove, M. (1974) Household and economy toward a new theory of population and economic growth. J. Poli. Econ. 82: 200.

Nerlove, S.B. (1974) Women's workload and infant feeding practices: A relationship with demographic implications. Ethnology 13: 207.

Newton, N. and M. Newton (1967) Psychological aspects of lactation. New Eng. J. Med. 277: 1179-1187.

Nicholaus, D. (1977) Interview with one of the authors (TG), June 10.

North, J., et al. (1975) Women in National Development in Ghana. Prepared for USAID/Ghana; April.

Nutrition Reviews (1975) Lactation and composition of milk in undernourished women. Nutr. Rev. 33: 42.

Nutrition Unit, Ministry of Health (1968) Nutrition Survey at Tefle, Lower Volta, Ghana. Ghana J. of Child Dev. 1(1): 17-39.

Ofosu, S.B. (1974) The supply of milk and milk substitute in Ghana: an analysis of the alternatives. Thesis, University of Ghana, Legon.

Ofosu-Amaah, S. (ed) (1974a) Proceedings of the National Food and Nutrition Conference. "Nutrition and the Development of Ghana". Accra, 8-10 April, 1974.

Ofosu-Amaah, S. (1974b) The effect of malnutrition on the community. In: Ofosu-Amaah, 1974a, pp. 320-326.

Ofosu-Amaah, S. (1975a) The growth of children in Accra. In: Owor, R., et al. (eds) The Child in African Development. Nairobi: East Africa Literature Bureau, pp. 29-32.

Ofosu-Amaah, S. (1975b) Reflections on the health budget; a preliminary analysis of the 1974/75 Ministry of Health Budget. Ghana Med. J. 14: 215-222.

Okala, C. and S. Mabey (1975) Women in agriculture in southern Ghana. Manpower and Unemployment Research in Africa. 8-13 Nov., pp. 13-40.

Okali, C. and R.A. Kotey (1971) Akokoaso: A Restudy. ISSER Tech. Rep. No. 15. Univ. of Ghana.

Oomen, H.A.P.C. (1961) The Papuan child as a survivor. J. Trop. Ped. 6: 103-121.

Oomen, H.A.P.C., et al. (1954) Makanan, Kesehatan dan Keadaangizi anak-anak ketjil; Berita Kementerian, Kesehatan Republik Indonesia III, 5. cited by Rohde, 1974.

Orraca-Tetteh, R. (1972) Report on the survey of the nutritional status of the population of Ogbojo (Near Madina), conducted in December, 1972, p. 2. Department of Nutrition and Food Science, University of Ghana.

Orraca-Tetteh, R. (1973) Report on the survey of the nutritional status of the population of Ogbojo (near Kwabenya), conducted in December, 1973, p. 4. Department of Nutrition and Food Science, University of Ghana.

Orraca-Tetteh, R. (1975) Report on the survey of the nutritional status of the population of Ogbojo (subvillage of Ablekuma), conducted in November, 1975, p. 4. Department of Nutrition and Food Science, University of Ghana.

Osborn, G.R. (1968) Stages in development of coronary disease observed from 1,500 young subjects. In: Le role de la pario arterielle dans l'artherogenese. Colloques Internationaux du Centre National de la Recherche Scientifique, Paris. Editions du Centre National de la Recherche Scientifique. c.f. Davies, D.F. Milk protein and other food antigens in atheroma and coronary heart disease. Amer. Heart J. 81: 289.

Osei-Yaw, A. (1976) Evaluation of Nutrition Rehabilitation Centres. Typed report.

Oseid, B.J. (1975) Breastfeeding and infant health. Clin. Obstet. Gyn. 18(2): 149-173.

Overseas Business Reports (1976a) Market Profile - Ivory Coast. Overseas Business Reports 50: 28.

Overseas Business Reports (1976b) Market Profile - Ghana. Overseas Business Reports 51: 16.

Pariboni (1977) FAO Statistical Division, Personal Communication.

Pasricha, S. (1958) A survey of dietary intake in a group of poor, pregnant and lactating women. Ind. J. Med. Red. 46: 605-609.

Passmore, R., et al. (1974) Handbook of human nutrition requirements. WHO monograph Series #61. Geneva: WHO.

Peckan, S. and S. Ngui (1967) Food procurement and consumption patterns, Danfa and Jamestown. Paper #8. In: Fellowship Course in Food Science and Applied Nutrition.

Pellett, P.L. (1976) Marasmus in a newly rich urbanized society. Ecol. of Food and Nutr. 6(1): 53.

Peterkin, B. and S. Walker (1976) Food for the baby...cost and nutritive value considerations. Family Econ. Rev. Fall, 1976. pp. 3-8.

Piel, M. (1972) The Ghanaian factory workers: Industrial Man in Africa. Cambridge U. Press, London.

Pitt, J. (1976) Breast milk leukocytes. Ped. 58(5): 769-770.

Plank, S.J. and M.L. Milanesi (1973) Infant feeding and infant mortality in rural Chile. Bull. WHO 48: 203.

Popkin, B. (1972) Economic Benefits from the Elimination of Hunger in America. Public Policy 20: 133.

Popkin, B. (1975) Economics and nutritional policy. Arch. Latin. de Nutr. 25: 7.

Popkin, B.M. (1976) (Revised, Aug.) The role of the rural Filipino mother in the determination of child care and breastfeeding behavior. Institute of Economic Development and Research, School of Economics, U. of Philippines Discussion Paper No. 76-12.

Popkin, B.M. (1978) Economic determinants of breastfeeding behavior: the case of rural households in Laguna, Philippines. In: Nutrition and Human Reproduction, W.H. Mosley (ed). Plenum Publ. Co.

Popkin, B.M. and F.S. Solon (1976) Income time, the working mother and child nutriture. J. Trop. Ped. 22: 156.

Population Reference Bureau (1976) World Population Growth and Response, 1965-1975. Washington.

Prices and Incomes Board, Ghana (1976) Prices and Incomes Journal, Vol. 2, No. 1. "Rent and labour survey Report", pp. 11-21.

Proja-Ronchi (1977) FAO Nutrition Officer, personal communication, May 2.

Psiaki, D. and C. Olson (1977) Current Knowledge on Breastfeeding, a review for medical practitioners. Extension Publication, available from Division of Nutritional Sciences, Cornell University, Ithaca, NY 14853 ($2.50).

Puffer, R.R. and C.V. Serrano (1973) Patterns of mortality in childhood. Report of the Inter-American Investigation of Mortality in Childhood. PAHO/WHO. Scientific Publ. No. 262, Washington, D.C.

Rajalakshmi, R., et al. (1974) Ascorbic acid metabolism during pregnancy and lactation. Baroda J. Nutr. 1: 117-134.

Ramos-Galvan, R. (1969) Nutritional needs and feeding practices in the first year of life. Proc. West Hemi. Nutr. Cong. II, AMA, Chicago, 1968. p. 18. Comments and Questions, pp. 29-30.

Rao, K.S., et al. (1959) Protein malnutrition in South India. Bull. WHO 20: 603-639.

Raphael, D. (1973) The Tender Gift: Breast Feeding. Englewood Cliffs, N.J. Prentice-Hall.

Ravelli, G.P. (1972) Enquete Nutritionnelle en Milieu Rural Africain Village d'Adahou S/P de Toumodi, Cote d'Ivoire. These presentee a la Faculte de Medecine de l'Universite de Berne, pour l'obtention du titre de Docteur en Medecine. Institute de Chimie Medicale a l'Universite de Berne. July.

Reddy, B., et al. (1977) Antimicrobial factors in human milk. Acta. Paed. Scand. 66: 229-232.

Republic of Ghana (1969) Population planning for national progress and prosperity: Ghana Population Policy. Accra-Tema: Commissioner for Economic Affairs.

Reusse, E. (1968) Ghana's Food Industries 1968, an economic analysis. UNDP, EA:SF/GHA/68.

Reutlinger, S. and M. Selowsky (1976) Malnutrition and Poverty. World Bank Staff Occasional Paper #23. Johns Hopkins U. Press, Baltimore.

Rimmer, D. (1976) Ghana, Economy. In: Africa South of the Sahara 1976-77. Europa Publications Ltd., London.

Roberts, S.A. and D.L.J. Freed (1977) Neonatal IgA secretion enhanced by breast feeding. Lancet 2: 1131. Nov. 26.

Robinson, M. (1951) Infant morbidity and mortality. A study of 3266 infants. Lancet 2: 788.

Rohde, J.E. (1974) Human milk in the second year. Paediatrica Indonesiana 14: 198-207.

Rosa, F.W. (1975) Breast-feeding in family planning. PAG Bull. 5(3): 5.

Rutishauser, I.H.E. (1974) Factors affecting the intake of energy and protein by Ugandian preschool children. Ecol. Food Nutr. 3: 213-222.

Sai, F.T. (1958) Food Requirements of populations with special reference to stress groups, introductory statement. Nutrition Seminar for English speaking countries and territories in Africa south of the Sahara. Kampala 25-29, Nov. 1957. FAO ETAP report No. 960. Rome.

Sai, F.T. (1967) The impact of urban life of rural immigrants and its repercussions on the nutritional status of the community. Ghana Med. J. 6(4): 134-139.

Sanger, C. (1976) It costs as much to heat the pot as to fill it. The IDRC Reports, 4(4): 7-9. December.

Schlesinger, J.J. and H.D. Covelli (1977) Evidence for transmission of lymphocyte responses to tuberculin by breast-feeding. Lancet 2: 529-532. September 10.

Schultz, T.W. (1961) Investment in human capital. Amer. Econ. Rev., March, p. 1.

Scrimshaw, N.S., et al. (1968) Interactions of Nutrition and Infection. WHO monograph Series No. 57. Geneva.

Selowsky, M. and L. Taylor (1973) The economics of malnourished children: an example of disinvestment in human capital. Econ. Dev. & Cultural Change 22(1): 17.

Sharma, N.L., et al. (1955) Infant feeding, diarrhea, and malnutrition. J. Trop. Ped. 1: 117.

Shukers, C.F., et al. (1932) A quantitative study of the dietary of the human mother with respect to the nutrients secreted into breast milk. J. Nutr. 5: 127-139.

Sieye, A. (1975) Le Developpement Psychobiologique de l'enfant Quest-Africain. These de doctorat de troisieme cycle de psychologie. Universite Rene Descartes.

Simic, B.S. (1971) Nutrition and disease related to nutritional status of the population in Ghana. Food & Nutr. in Africa, No. 10, pp. 19-35.

Sjölin, S. (1976) Present trends in breast feeding. Current Med. Res. and Opinion 4 (Suppl 1): 17-22.

Smart, K.F. (1972) Malnutrition and endemic diseases: their effects on education in the developing countries. Report on a meeting of experts from 2-6, November, 1970. Hamburg: Unesco Inst. for Education.

Snyder, D.W. (1974) Economic determinants of family size in West Africa. Demography 11(4): 613-629. November.

Sosa, R., et al. (1976) The effect of early mother-infant contact on breast feeding, infection and growth. In: Breast Feeding and the Mother, Ciba Foundation Symposium 45, Amsterdam: Elsevier, pp. 179-193.

South, M.A. (1971) IgA in the neonatal immunity. Ann.N.Y. Acad. Sci. 176: 40.

Steckle, J. (1972) Effects of Industrialization on Food Consumption Patterns. A Study in Two Ewe Villages. ISSER Tech. Publ. Series No. 20. Legon.

Steckle, J.M. (1975) Food utilization in Ghana; seasonal economics, Volta region. Thesis, U. of Reading (U.K.)

Stevens, C.M. (1977) Health and economic development: longer-run view. Soc. Sci. & Med. 11: 809-817.

Stitt, P.G., et al. (1962) Some practical considerations of economy and efficiency in infant feeding. Am. J. Pub. Hlth. 52: 125-142.

Stoch, M.B. and P.M. Smythe (1976) 15-year development study on effects of severe undernutrition during infancy on subsequent physical growth and intellectual functioning. Arch. Dis. Child. 51: 327-336.

Stoliar, O.A., et al. (1976) Secretory IgA against enterotoxins in breastmilk. Lancet 1: 1258-1261.

Stuart, H.C. and S.S. Stevenson (1959) Physical growth and development. In: Nelson, W. (ed) Textbook of Pediatrics, Seventh Ed. Philadelphia: W.B. Saunders.

Svanberg, U., et al. (1977) Breast milk composition in Ethiopian and Swedish mothers. III. Amino acids and other nitrogenous substances. Am J. Clin. Nutr. 30: 499-507.

Tassovatz, B. and A. Kotsitch (1961) Le lait de femme et son action de protection contre les infections intestinales chez le nouveau-ne. Sem. Hop. Paris 37: 1649-1652.

Thomson, A.M. and A.F. Black (1975) Nutritional aspects of human lactation. WHO Bull. 52: 163-177.

Thomson, A.M., et al. (1970) The energy cost of human lactation. Br. J. Nutr. 24: 565-572.

USDA (1977) Foreign Agriculture Service. Ivory Coast: Agricultural Situation, No. IV, 7007, January 24, p. 7.

Vahlquist, B. (1975) Evaluation of breast feeding in Europe. Env. Child Health, Feb. 11-18.

Van der Mei, J. and D.W. Belcher (1974) Comparing under-five programmes in a hospital-based clinic and in satellite mobile clinics. Tropical and Geogr. Med. 26: 449-456.

Van Ginneken, J.K. (1977) The impact of prolonged breast feeding on birth intervals and on postpartum amenorrhoea. Conference on Nutrition and Reproduction, NRC/NICHHO, Bethesda, 13-16 February.

Van Steenbergen, W.M. (1975) Nutrition and the Akamba Child (for internal use only). Mimeo, Royal Tropical Inst. Amsterdam. Medical Research Centre, Nairobi, Kenya.

Van Steenbergen, W.M. (1977) Nutrition and the Akamba Child (part II). Mimeo, Royal Tropical Inst. Amsterdam. Medical Research Centre, Nairobi, Kenya.

Vyas, N. and J.C. Leith (1974) Labour force participation of women in Ghana. Econ. Bull. of Ghana 4: 53-60.

WFP/CFA (1976) Vitamin enrichment of dried skim milk (with special reference to vitamin A). In: Food Aid Policies and Programmes. WFP/CFA: 2/7-C Add. 1 August. Second Session, Rome, 15-26 November 1976. Agenda Item 7(c).

WHO (1976) Regional Office for Africa. Apercu sur l'Alimentation et la Nutrition, Cote d'Ivoire, p. 2.

Wagenbuur, H.M.T. (1972) Labour and Development. U. of Cape Coast Social Studies Project. Research Report Series No. 11.

Wallgren, A. (1945) Breast-milk consumption of healthy full-term infants. Acta. Paed. Scand. 32: 778-790.

Wasz-Höckert, O. (1973) Lysozym i mjölk och dess belydelse for infektionssydd. (Lysozyme in milk and its importance for protection against infection). Semper Nutrition Symposium, Näringsforskning (Suppl. No 8) 17: 67.

Watts, B.K. and A.L. Merrill (1963) Composition of Foods. USDA Agricultural Handbook #8.

Watt, J., et al. (1953) Diarrheal disease in Fresno County, California. Am. J. Pub. Hlth. 43: 728-741.

Welbourn, H.F. (1958) Bottle feeding: a problem of modern civilization. J. Trop. Ped. 3: 157.

Welffens, L. (1977) UNICEF Program Administrator, Abidjan. Personal communication.

West Africa (1976a) Ghana brings petty traders to book. West Africa No. 3062, 8 March, 1976, pp. 294-295.

West Africa (1976b) Archeampong speaks. West Africa No. 3063, 15 March, 1976, p. 333 (interview with Ghana's Head of State).

Westlake, C.A. and D.A. Jones (1975) Cost of breast-feeding (letter). Lancet 2: 1261. Dec. 20.

Wheeler, E.F. (1974) "Cornmeal and Condensed Milk" assessment of a Jamaican supplementary food mixture. WI Med. J. 23: 69.

Whichelow, M.J. (1976) Cost of breast-feeding (letter). Lancet 1: 586. March 13.

Wilkinson, P.W., et al. (1973) Inaccuracies in measurement of dried milk powder. Brit. Med. J. 2: 15-17.

Woodruff, C.W., et al. (1977) Iron nutrition in the breast-fed infant. J. Ped. 90: 36-38.

Yekutiel, P., et al. (1958) A field study of infantile diarrhea in Israel. J. Trop. Ped. 3: 175.

Zaki, M.H., et al. (1978) Dieldrin in milk: the experiences of Suffolk County, New York. Amer. J. Pub. Hlth. 68: 260-262.

Ziegler, E.E. and S.J. Fomon (1971) Fluid intake, renal solute load, and water balance in infancy. J. Pediat. 78: 561-568.

Zöllner, N., et al. (eds) (1977) Tables of recommended nutrient intakes in different European countries. Nutr. Metab. 21: 251-279.

(Additional References, p. 154)

ADDITIONAL REFERENCES

Africa (1976) Ghana, the cocoa scene. Africa No. 60, August, p. 53.

FAO (1977) The Fourth World Food Survey, FAO Food and Nutrition Series No. 10, Rome.

Gaisie, S. K. (1975) Levels and patterns of infant and child mortality in Ghana. Demography 12(1): 21.

May, J. M. (1968) The Ecology of Malnutrition in the French Speaking Countries of West Africa and Madagascar. New York: Hafner, pp. 3-127.

Ofosu-Amaah, S. (1968) Report on Nutrition in Ghana. West African Conference on Nutrition and Child Feeding. Sponsored by USAID. Dakar, Senegal. March 25-29.

Paxton, J. (ed.) (1975) The Statesman's Yearbook, 1975-76. London: Macmillan, p. 313.

Posner, J. L. (1973) Rice in the development of Ivory Coast agriculture. Cornell Agricultural Economics Staff Paper No. 73-6.

Sai, F. T. (1975) Nutrition in Ghana--a case study. Bellagio Conference on Nutrition and Governmental Policy in Developing Nations. Sponsored by the Rockefeller Foundation. Villa Serbelloni, Italy. September 20-23.

West Africa. (1976c) No. 3100, 29 November, p. 1807.